PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

AUGUST 1957

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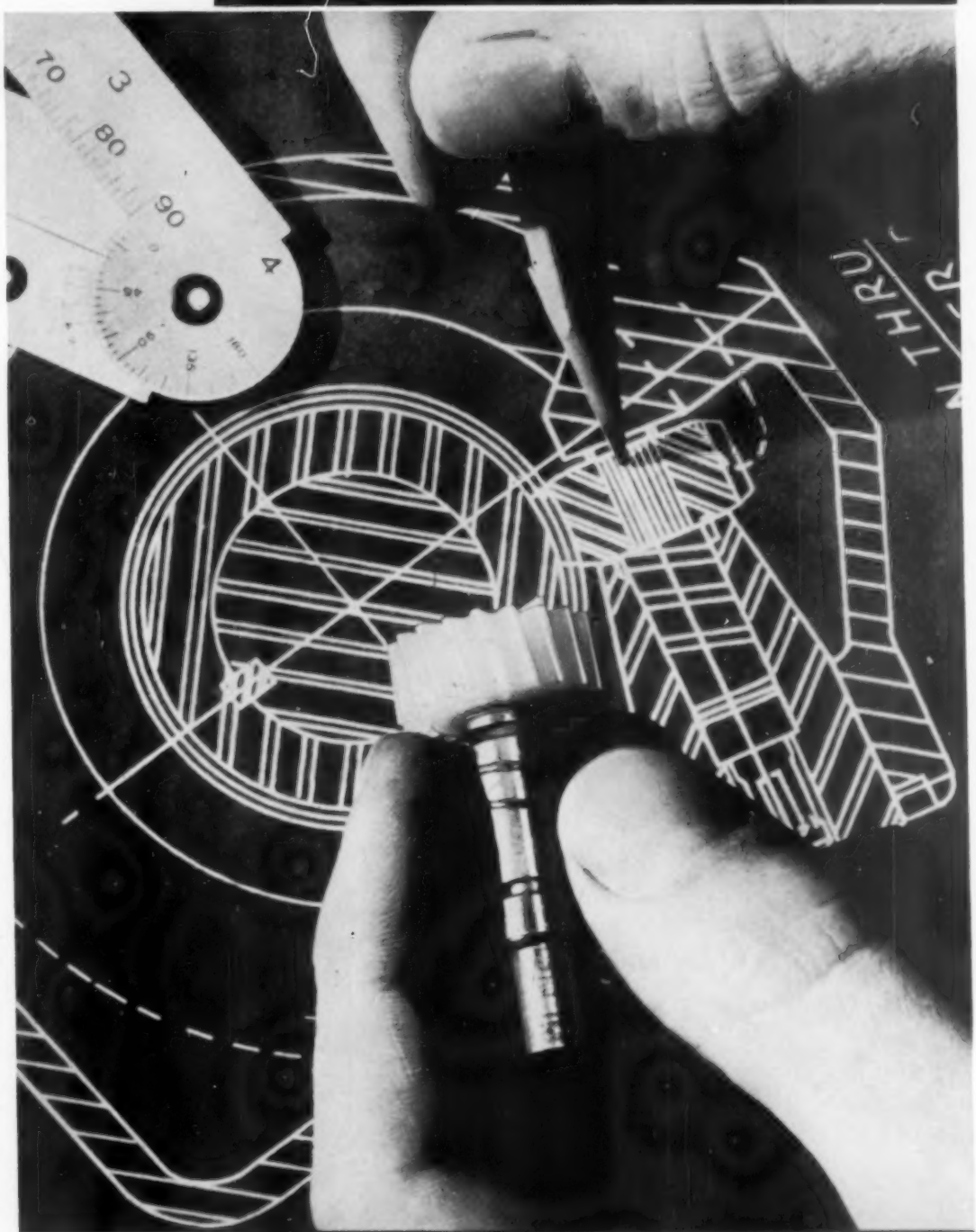

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See Feature Story/page 650

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PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

AUGUST 1957 VOLUME III, NUMBER 8

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Article

Highlights

Pressure Measurement in Injection Molding by Use of Ejector Pins. (p. 629)
Desire for better production is leading to more and more instrumentation in plastics processing equipment. This paper gives the results of an investigation on the use of strain gages for measuring mold cavity and injection nozzle pressures. Accurate measurement should solve many of the molder's problems.

•

Colorants for Plastics. (p. 633)
The color pigments used in plastics are reviewed. These include: yellows, oranges, reds, greens, blues, and violets. Pigments and dyes are compared, and a table showing the relative lightfastness of pigments is included.

•

Can Performance Tests Be Developed for Finished Molded Articles? (p. 640)
Scarcity of design data makes it difficult, particularly for the beginner, to consider and use plastic as engineering materials. A program for organizing performance-test data is proposed.

•

Molding-Finish Interactions in Fatigue of Glass-Reinforced Polyester Resins. (p. 644)
The effect of various finishes and cure cycle speeds on the properties of laminates are reported and evaluated. Constant-stress flexural fatigue data, flexural strength, flexural modulus, damping, and dynamic modulus measurements were examined.

Previews

The following articles will be published in the Sepember issue:

Flexural Fatigue Strengths of Reinforced Thermosetting Laminates. B. B. Pusey, Development Department, Bakelite Co., Bound Brook, N. J.

Effect of Blow-Up Ratio on Polyethylene Blown-Film Properties. C. G. Kucher, Sr. tech. service rep., Eastern Region, Spencer Chemical Co., Kansas City, Mo.

Automatic Pellet Deflashing of Moldings with Metal-Pin Inserts. E. F. Anderson, special engineer, Wheelabrator Corp., Mishawaka, Ind.

Synthetic Fibers in Formable Acrylic Sheet. D. E. Jackson, rsch. chemist, and D. A. Moore, rsch. engineer, Pioneer Rsch. Lab., Textile Fibers Department, E. I. du Pont de Nemours, Wilmington, Del.

Letters to the Editor

Wants Plastics Fire Hazards Booklet

Dear Sir:

Commenting on "Letters to the Editor" for May, I'm heartily in favor of Mr. Jebens' idea about a Fire Hazard booklet along the lines of Mr. Fina's idea (see Guest Editorial in February). It might be entitled "Plastics—A Fire Hazard," and copies made available free, via the plastics societies, to all fire chiefs for use in their plant and warehouse inspections as a "bible."

It must be written in very simple language, with bold and spaced type and frequent sub-titles, so that even a youthful grammar school student would understand it. Yet it must sound authoritative, with source footnotes if "proof" is ever needed in a controversy. Such books would also be handy for insurance investigators.

In Boston, fire inspectors still remember the dreadful Cocoanut Grove fire caused by igniting drapes coated with cellulose nitrate lacquer. The fire department inspector in this area thinks that even acrylic is explosive, and issues orders for its destruction if kept without a special permit. Anyone with a pail of liquid plastic like polyester or vinyl must refer to it as a "synthetic varnish." When the fire inspector is asked for the source of his ideas about all plastics being dangerous, he replies, "It's in the book at the stationhouse."

In a booklet published by the plastics industry, the format might well be in question-and-answer form, as such layouts seem effective in other fields.

Frank Pray, Pres.
Technicraft Co.
Boston, Mass.

• • •

Likes June Editorial

Dear Sir:

I confess I have just caught up with my June issue of PLASTICS TECHNOLOGY, which is pretty good lag time considering the number of magazines I try to read. Your editorial in that issue struck me as being very important and forceful. The problem of engineering design with plastics has been one of the critical abuses of our industry, and I am happy to see an important publication such as yours take up the cry.

I like to think that we in du Pont are holding up our end in educating those people involved in designing with plastics on correct procedures. The nature and arrangement of the data in our new book, "Designing with Du Pont Plastics," is aimed at this objective. If enough people, such as yourself, bring this to the attention of the designing public, much less in the way of designing by analogy will occur. We hope you keep it up.

A. A. Pavlic
Manager, Plastic Sales
Polychemicals Department
E. I. du Pont de Nemours & Co.
Wilmington 98, Del.

(*Comments, both pro and con, are always welcome. We try at all times, and most particularly in our editorials, to reflect the feelings of the industry.—Editor*)

• • •

Tygon-Like Tubing

Dear Sir:

We are writing in reply to your letter published in PLASTICS TECHNOLOGY concerning a source for Tygon-type tubing.

We are currently producing large quantities of this tubing, both for our own use and on a custom basis. Our plant is new and well equipped to produce for a wide range of requirements.

F. E. Newman
Plastics Production Mgr.
Baxter Laboratories, Inc.
Cleveland, Miss.

(*This letter has been forwarded to the original inquirer.—Editor*)

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

A letter will not be printed if publication is not desired by the sender, and the identity of the writer will be withheld, if desired.

—The Editor

"Quote . . . Unquote"

Plastics as Construction Materials

"Risking oversimplification, the basic problems involved in utilizing plastics as standard engineering materials of construction are (1) a lack of awareness among engineers and designers of the plastic materials available and their properties; and (2) confusing terminology or language difficulties (that is, that the engineer and designer do not understand the language of the plastics branch of the chemical industry and, just as frequently, the plastics industry does not understand the language of the engineer and designer).

"These basic problems lead directly to a number of hindering situations. These are an incompatibility with existing standards and codes; a lack of experimental use which would provide the performance information so vitally needed, and a natural hesitancy to proceed in the area of the 'unknown' which has prevented many natural advances in plastic technology. These problems have been recognized by the plastics industry and concentrated action is being given to reducing them."

M. F. X. Gigliotti, Manager of Structural Plastics Engrng., Plastics Div., Monsanto Chemical Co., Springfield, Mass.

• • •

The Science Manpower Shortage

"It is apparent that increasing the percentage of students who attain degrees in science and engineering is the most effective way of heading off a serious problem.

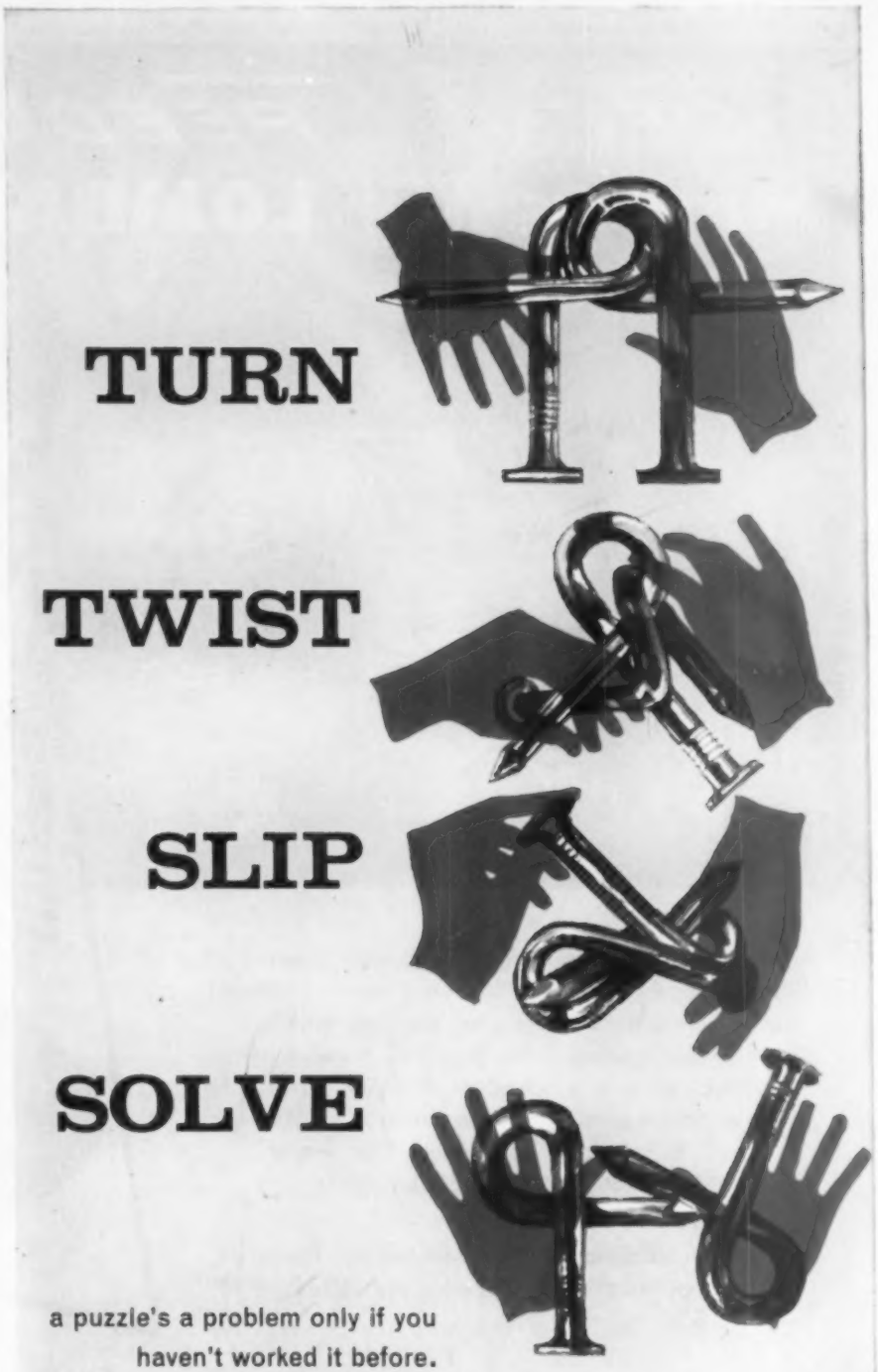
"This is not an insurmountable task. Today, 18.6% of those who are graduated are scientists and engineers. In order to provide a supply of scientists and engineers to balance the demand, this percentage should be raised to 20-22% each year.

"In other words, 186 of every 1,000 who are graduated today are scientists or engineers. What is needed is 20 to 30 more science and engineering graduates for each 1,000, raising the ratio to 205-215: 1,000.

"Another effective means of increasing the supply of scientists and engineers is to close the gap more rapidly between the number of students who graduate from high school and the number of students who graduate from college. . . .

"Each year thousands of potential scientists and engineers are lost because they do not go on to college from high school or, if they do, they fail to graduate from college. . . . Of those who do enter college, only one-half ever graduate."

"A Study of the Scientific Manpower Problem of the United States" The B. F. Goodrich Co. Akron, Ohio



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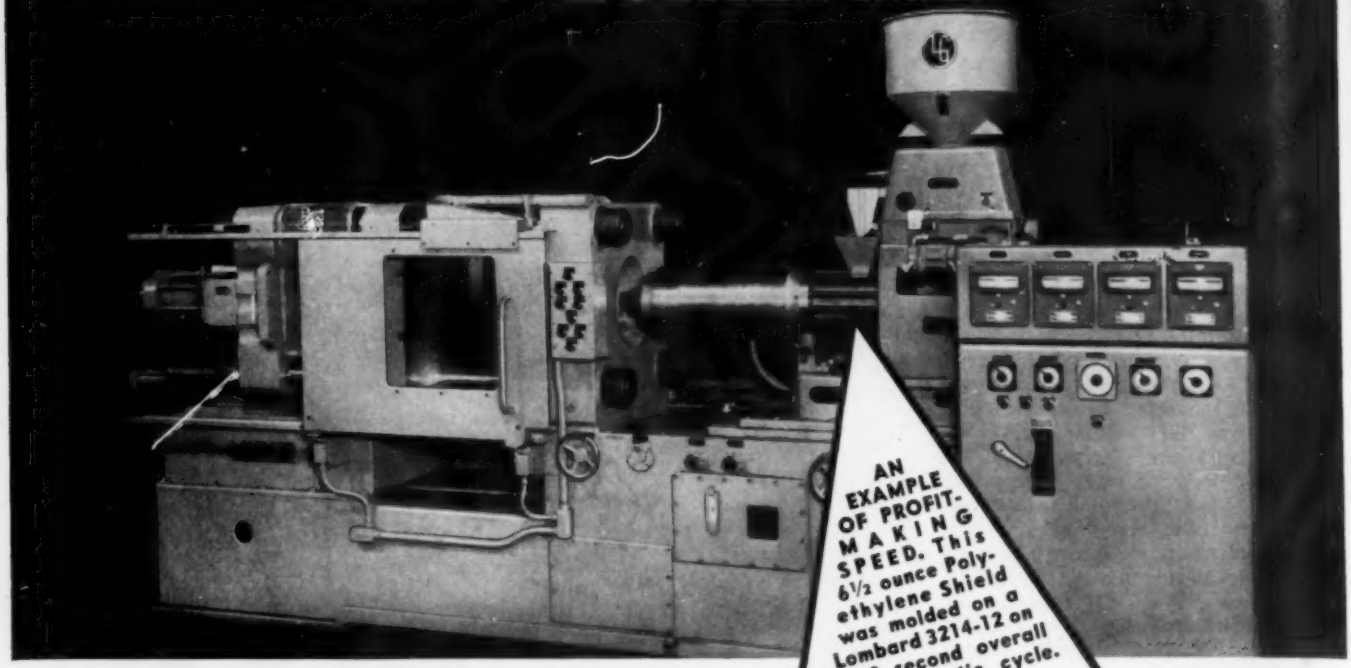

AN EXAMPLE OF PROFIT-MAKING SPEED. This 6½ ounce Polyethylene Shield was molded on a Lombard 3214-12 on a 10 second overall semi-automatic cycle.

Model 3214-12 provides greater locking pressure at 438 tons than any similar 12 ounce machine offered today. This greater pressure prevents flashing; makes larger casting area possible. These features combined with a speed of *420 dry cycles per hour assure production at a profit* . . . . . Weigh Feed is standard equipment. This model is available with 20″ platen stroke.

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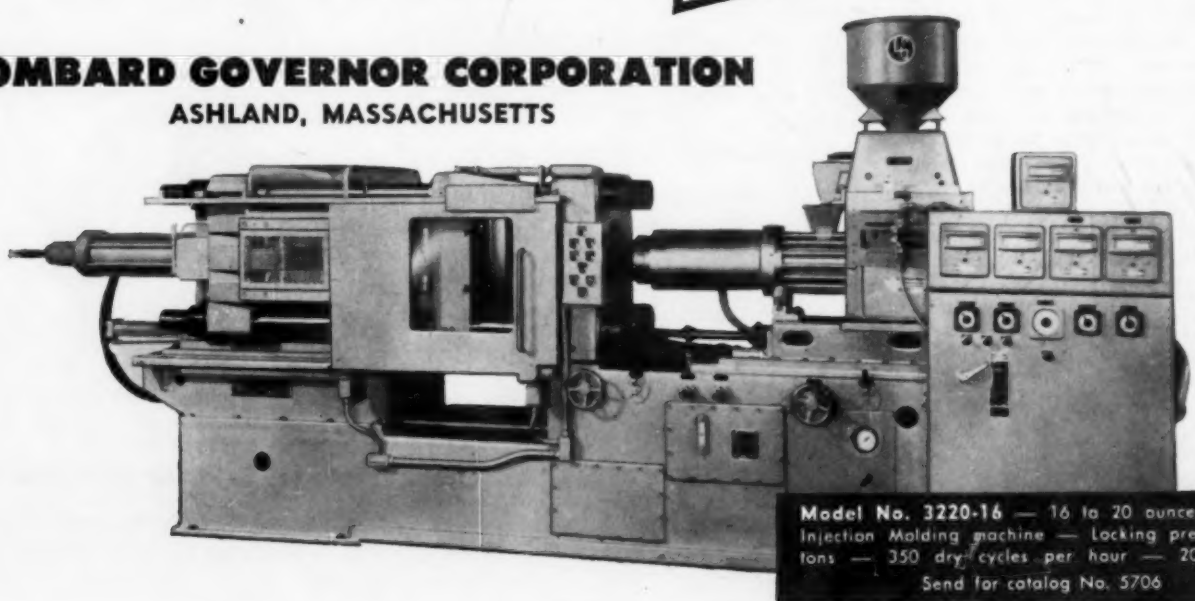

Model No. 3220-16 — 16 to 20 ounce Lombard Injection Molding machine — Locking pressure 438 tons — 350 dry cycles per hour — 20″ stroke.
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NEWS in BRIEF

Two companies mark anniversaries this year: Eastman Kodak Co., is celebrating 25 years of Tenite plastics production. Not generally thought of by the layman as a plastics pioneer, Eastman first marketed a plastic-based film in 1889. The year 1932, however, first saw Tenite acetate molding powder enter the market. Collette Mfg. Co., marks its fiftieth year in business. A producer of sports equipment, the firm is producing footballs and the like from vinyl plastisols.

The plastics industry must aproach its future in an atmosphere of mutual trust and cooperation, if production is to reach 6-billion pounds by 1960. The material supplier can help the molder solve processing difficulties if permitted, and not considered a spy for the competitor. The supplier feels that the surest way to grow is to help the customer to grow; therefore he is willing to put his facilities at the customer's disposal. (See guest editorial, page 639.)

Trends in the consumption of plastics for passenger cars are predicted in a marketing report published by the Agricultural Marketing Service of the Department of Agriculture. Although vinyls went from 5-45 million pounds in the last five years, their use is expected to taper off except in the lowest-priced models. Nylon, backed or un-backed, appears to be the material of choice material of the future.

Company expansions find the Marbon Chemical division of Borg-Warner Corp. opening a $10-million resins plant near Parkersburg, W. Va. E. I. du Pont is planning a major expansion of its Teflon producing facilities, also at Parkersburg. Chemtrol Corp. doubles its capacity for producing PVC and Penton ball valves by moving to larger quarters in Compton, Calif. Expansion and reorganization of its technical sales-service facilities has been announced by Morton-Withers Chemical Co.

Company developments in the plastics industry saw one of the country's leading producers of clay and brick pipe entering the plastics field. Evans Pipe Co., has established a new division, Evanite Plastics Co., which will manufacture polyethylene pipe. Cadillac Plastic & Chemical Co., supplied and fabricated an acrylic model of a water-pumping station, which will enable the City of Detroit to save over $100,000. A technique for spin-welding thermoplastic parts has been developed at Du Pont's sales service laboratory. A new firm, J. B. Durra & Co., has been established for marketing and consulting services to the plastics industry. Synthane Corp., offers king-size laminated plastic sheets. A new trademark has been adopted by Diamond Alkali Co.

New Materials of special interest (see pages 663-4): vinyl-plastisol stabilizer; low-viscosity vinyl resin; epoxy hardener; heat stabilizer for vinyls; clear primer for plastisols; two polyethylenes; rust-preventive spray; polyester thickener; and an ink series for vinyl printing.

New Equipment to be noted (see pages 666-7): mechanically-operated dehumidifying oven; rope-feed attachment for compression presses; vertical hydraulic press; and a line of mechanical high-vacuum pumps.

New Products worthy of mention (see pages 668-9): prefoamed epoxy resin blocks; Teflon-lined hose assembly; low-caliber polyester film; control-panel wiring ducts; irradiated polyethylene tips; and fluorocarbon tubing.

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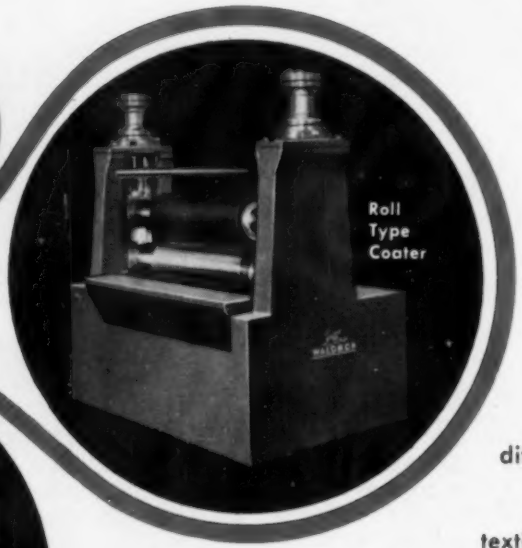

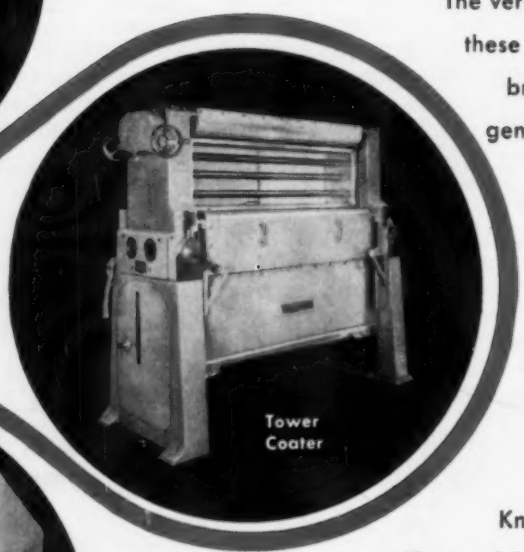

Illustrated are four distinctly different types of Waldron Coaters for processing paper, plastic, textile or metal webs. Each is best for certain requirements and certain conditions. The very fact that we can offer not only these four types but others suggests a breadth of service not to be found generally. We are fully aware that it is not in the interests of good processing to expect one or two units to take care of *all* the coating problems. Industry should not be asked to modify its coating steps to accommodate a single design or even two designs.

Knowing of the variety of Waldron Types of Coaters, would you care to have a Waldron Engineer discuss your problem? Perhaps he could be of help in the selection and also show how it can be tied in to the best advantage with the rest of the production line.

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PLASTICS TECHNOLOGY

AUGUST, 1957

EDITORIAL: Meeting the Engineering Challenge to Plastics

Now that plastics are well on their way towards becoming true materials of engineering, we can repeat the problem posed originally in our March 1955 editorial. From the vantage point gained by the lapse of more than two years we can see that some of the limitations of 1955 have been conquered, but it is apparent that we still have far to go before plastics can truly be termed a science or technology.

•

The plastics industry is now in the intermediate stage between adolescence and maturity. The stage is set for continued advancement, and the need for this growth is recognized by everyone concerned with the welfare of the industry. Now, what can be done by the industry itself to help?

The first responsibility is that of the plastic materials manufacturers. The nature of the industry is such that the processors and fabricators, while numerous, are individually too small to assume the burden of engineering research on materials. This phase of the work has fallen to a large extent on the materials suppliers who have the facilities.

Fundamental knowledge of the chemical behavior of plastics is needed, and work on this aspect has been in progress from the start. Also under way is work to obtain the necessary basic information on processing principles and techniques. But only in the past few years has this work been conducted in planned scientific programs designed to give correlatable results.

As yet, plastics property data for design and application engineers is still far from adequate. It is true that each materials manufacturer furnishes some property data on his materials, but a real engineering case-book for each material is still not available.

To illustrate, each supplier gives a tensile figure for his material. In many cases, he may even give one or more additional figures for non-room temperatures. The designer, however, must have complete tensile data over the entire temperature service range of the material.

•

It must be re-emphasized that there are no good or bad physical properties, only true or false figures. A property good for one application may be entirely unsuitable for another, yet the material is still the same. Just because Material "A" has a higher impact strength than Material "B" does not make it better for each application, especially if the application in question has a very low impact strength requirement. Obviously, a comparison of the two materials will be meaningless from the designer's viewpoint. Also, for that matter, from the user's viewpoint.

Complete property data must be made available for each plastics material to ensure proper application. Failure to do so leads to suspicion by potential users of plastics, and service failures of plastic parts that reflect back on the entire industry. The continuing challenge to plastics is clear.

Arthur M. Merrill

Editor

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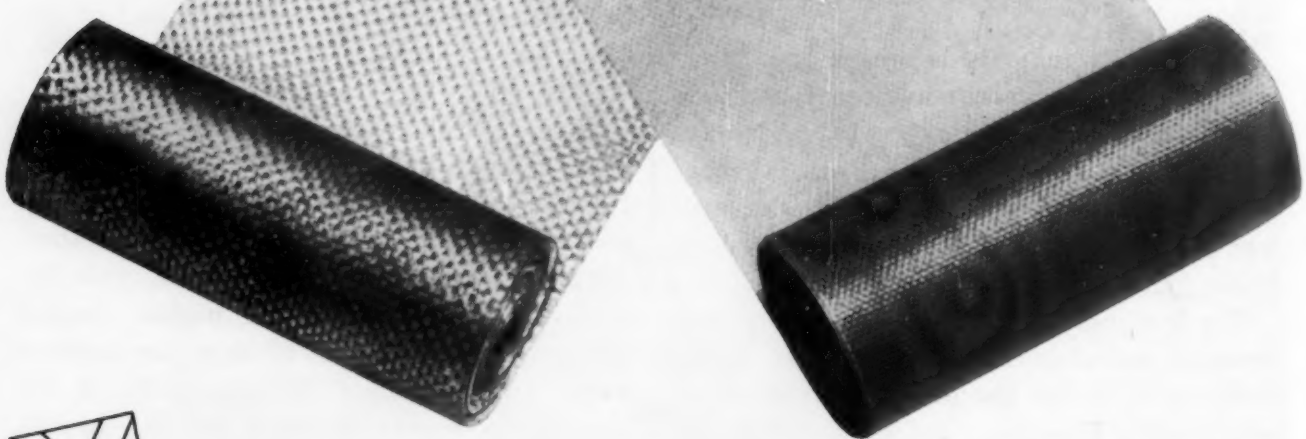

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PLASTICS TECHNOLOGY

Pressure Measurement in Injection Molding by Use of Ejector Pins

Results of an investigation on the use of strain gages for measuring mold cavity and injection nozzle pressures.

P. D. KOHL, *Senior Engineer,*
Research Div., Polychemicals Dept.
E. I. du Pont de Nemours & Co., Inc.
Wilmington, Del.

IN plastics fabrication, as in many other manufacturing fields, the desire for better production at lower cost is leading to more and more instrumentation on plastics processing equipment. Like most manufacturing processes, injection molding of plastics can benefit from better pressure measurement. If the operator has a clear picture of the pressure changes in the machine, he can reduce rejects and improve quality pieces. It is reasonable to assume that one day soon plastic molding pressure will be controlled automatically to prevent either packing (over-pressure) or under pressure. If the molding pressure can be measured accurately, it can be controlled accurately.

Mold Cavity Pressure

One of the most important variables in injection molding is the pressure in the mold. For many years, this pressure was indicated only indirectly; i.e., using the hydraulic pressure on the injection ram. It is not always realized, however, that pressure in the mold under extreme molding conditions can vary from about 90% of the ram pressure down to about 10%. In critical molding situations, therefore, the picture of what is going on in the mold, as shown by the hydraulic pres-

Based on a paper presented at the 13th annual National Technical Conference, Society of Plastics Engineers, Inc., St. Louis, Mo., Jan. 17, 1957.

sure, must be tempered with long experience. Even with this experience, the trial-and-error time spent to obtain correct molding conditions can be expensive.

Since it is important that a clear picture of the pressure history of a molding be obtained, we set out to develop a method for measuring the pressure in the molding cavity.

In past years, a few attempts have been made at measuring the pressure in the mold cavity. The pressure gage developed by Spencer and Gilmore, of Dow Chemical Co., was quite successful. However, we wanted a gage that would be more readily adaptable to almost every mold type with a minimum of mold modification. In addition, we wanted a greater speed of response in order to measure hte high speed of pressure change in a mold. As it later turned out, this high speed of response was quite helpful in our studies because it allowed us to detect small pressure fluctuations and to interpret more easily the story that pressure curves had to tell. It was decided, therefore, to apply our experience with bonded wire strain gages in other services to pressure measurement in injection molds.

Strain gages usually are lengths of very fine wire glued to a paper backing. When this paper is attached to an object that is being stretched or compressed, the wire is stretched or compressed. The amount of such movement can be observed as a minute change in the electrical resistance of the wire.

Ejector-Pin Pressure Gages

Since most molds use one or more ejector pins to remove the finished part, we attempted to use the pin as our pressure gage. By bonding wire strain gages directly to the ejector pins, we were able to measure the load on the pin as a function of the pressure applied. Although these pins were unusually small in size (about 3/16-inch in diameter), by careful trimming and bonding techniques, we could mount strain gages on them and use only about 1-1½ inches of the pin length.

Figure 1 is a diagram of three pins used for pressure measurement. The first pin (top) is a standard ejector pin as received from a mold supplier. To this pin we bonded the gages shown. The second pin (center) is the same as the first, except that the head was ground off and a retaining ring groove cut into the end of the pin. The third pin (bottom) is one that can be threaded into the knock-out plate, and can be installed in most molds.

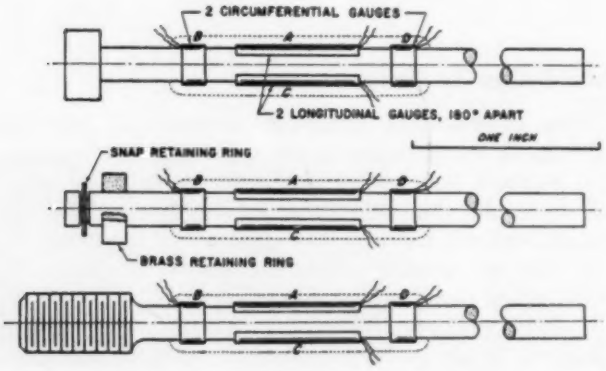


Fig. 1. Three pins with strain gages used for pressure measurement: (top) compression pin; (center) headless ejector pin; and (bottom) threaded ejector pin.

Paul D. Kohl was born in Terre Haute, Ind., on July 20, 1925. He attended Purdue University, receiving a B.S. in mechanical engineering in 1946. He joined Du Pont in September of that year, and was assigned to the Belle Works, Charleston, W. Va. In February, 1948, he was transferred to the Experimental Station in Wilmington. He is presently serving as project leader—design and mechanical development, for Du Pont's polychemicals department. An active member of ASME, Mr. Kohl lives with his wife and daughter in Glen Mills, Pa.

Figure 2 shows a typical installation in which the standard ejector pin was removed from the mold and replaced by a duplicate pin having mounted strain gages. This new pin travels with the ejector plate and acts as a normal pin for ejecting the molded part, but also measures pressure in the mold from the start of mold filling until the part is ejected. Figure 3 shows an ejector plate assembly with threaded-type pins in place.

Figure 4 shows a pressure trace from the oscillograph taken during the filling of an injection mold, and is typical of curves from ejector-pin pressure gages. The hydraulic pressure has been plotted in this diagram,

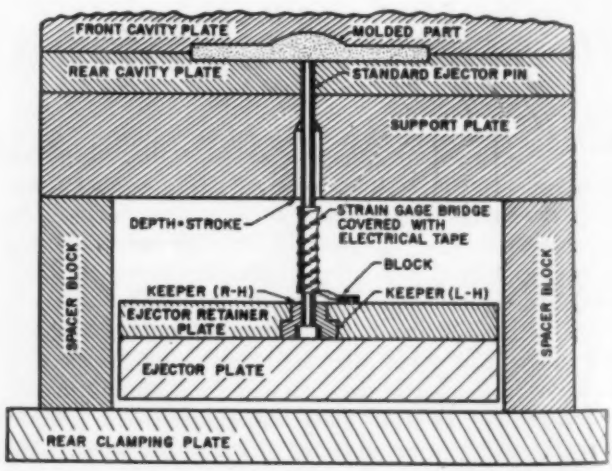


Fig. 2. Typical press installation for ejector pin pressure-measurement.

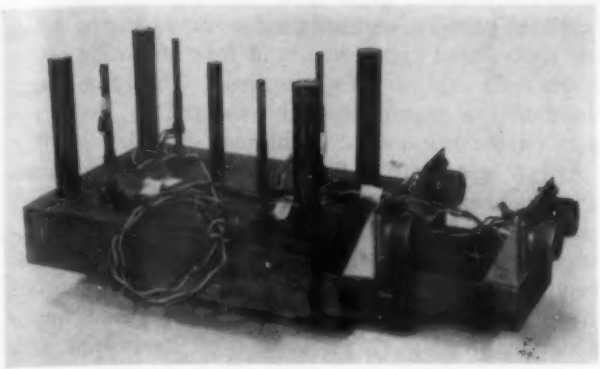


Fig. 3. Ejector plate assembly with threaded-type ejector pins.

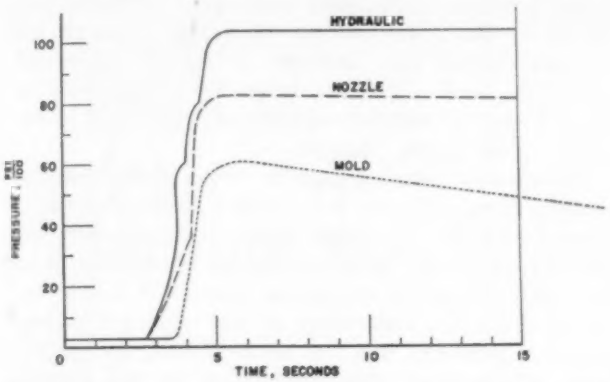


Fig. 4. Oscillograph pressure traces taken during filling of the injection mold.

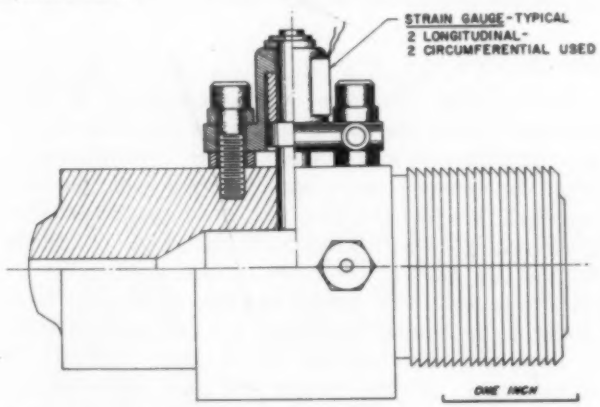


Fig. 5. Assembled strain gage in injection molding nozzle.

and it is evident that there is appreciable pressure loss between the hydraulic ram pressure and the mold-cavity pressure. There also are several special values obtainable from this curve, such as start and time of mold filling, gate freeze-off, etc., which will not be discussed here.

Our gages are calibrated with a Baldwin universal testing machine at the expected mold-operating temperature before installation in the mold and, again, with a force gage, after installation of the mold, so that we can check the calibration under operating conditions. In this way, any question as to whether the gages are

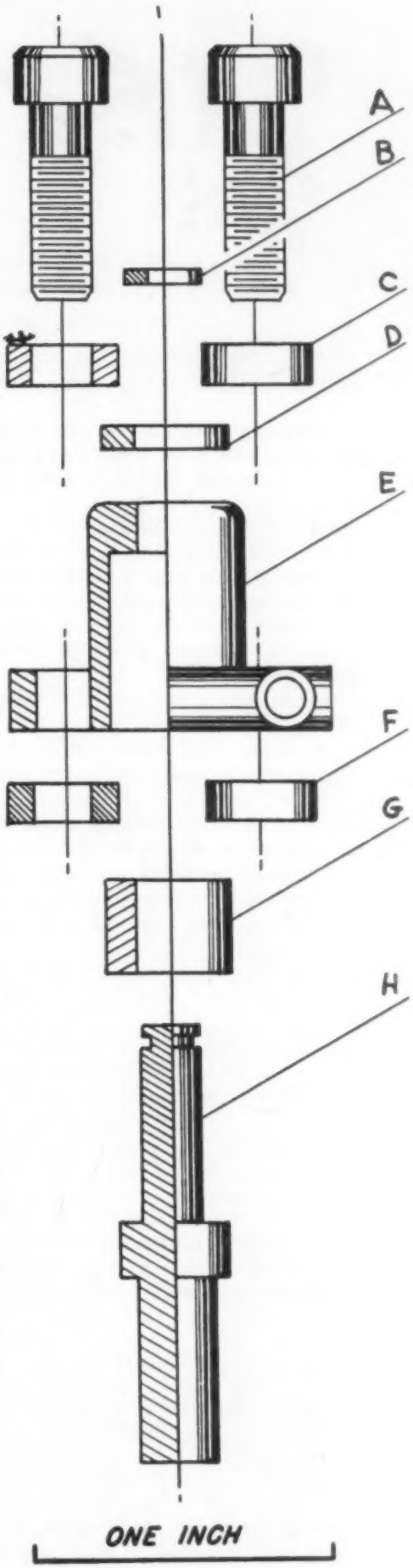


Fig. 6. Nozzle pressure gage components shown in order of assembly; A—Socket head cap screws; B—Retaining ring; C—Filled-phenolic washer; D—Teflon washer; E—Gage head; F—Filled-phenolic washers; G—Micarta spacer; and H—Gaging plunger.

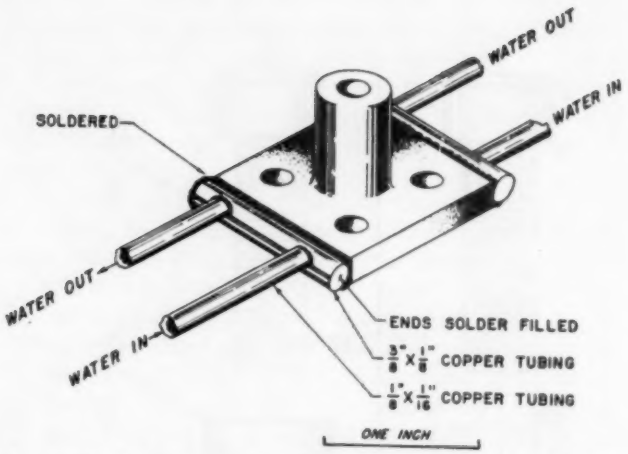


Fig. 7. Nozzle pressure gage head showing cooling manifolds.

operating and recording properly can be checked easily. We found it desirable to use heavy lead wire and a terminal block to prevent the wires from being broken or pulled loose from the knock-out pin. We also found it helpful to calibrate the gages in the mold where they stood up well, but were damaged sometimes while being removed from the mold for calibration.

The utility of these strain gage ejector pins is beyond our original expectations. They are very long lived and extremely accurate, if calibrated at regular intervals and installed properly.

We have found the virtues of these gages to be as follows:

(1) They can be used in most standard molds.

(2) Molding pressure is transmitted directly without moving parts.

(3) They require no additional openings in the mold, thus leaving no extra marks on the molded part.

(4) They have extreme sensitivity and reproducibility. We read pressure changes as small as 100 psi. in a 15,000-psi. total, and could see a change of 25 psi. at this pressure, if necessary.

(5) They have very high speed response, at least up to 70 cycles per second, (the maximum response of our recorder).

(6) The pins are unaffected by the temperature cycle in the mold cavity when the hot plastic is injected.

We believe that these strain gage ejector pins can be used commercially to help obtain better molded parts and to reduce the number of rejects and problems posed by difficult molding cycles. With good pressure indication available, problems can be solved more readily because the picture of what is happening will be clearer. We have certainly found the pins to be a good research tool, and believe they will be of appreciable help to anyone attempting to make better moldings on faster cycles.

Nozzle Pressures

The successful application of strain gages to measurement of mold pressure and the difficulties experienced in applying commercial gages to the measurement of plastic pressures in the nozzle suggested the use of a strain gage cell for nozzle-pressure measurement. Figure 5 shows an injection molding nozzle of a type we use, with a pressure gage in place. Figure 6 shows the pressure gage alone. The gage consists of a measuring plunger, an insulating spacer, a gaging head, four socket-head cap screws, and four insulating washers on each side of the gaging head. The force transmitted to the gaging head is measured by the strain gages on the thin-walled cylindrical section.

As can be seen from the drawing, there is an insulator to reduce heat conduction into the gage at each point of contact between the gaging head and the high-temperature metal parts. These insulators are a filled-phenolic composition. With a nozzle temperature of 270° C., the temperature of the gaging head was a maximum of 130° C. As those who have dealt with strain gages may know, a standard bonding cement for strain-gages use is good only to about 70° C.

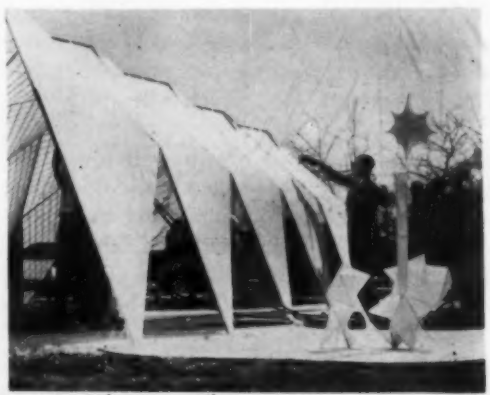
Although we might have used epoxy cements here (which we did afterwards on other gages), we elected to water-cool the gage, as shown in Figure 7. Although contact is small, the water keeps the gaging head to about 30-50° C. without evidence of a cold spot in the plastic at the gaging plunger.

These nozzle pressure gages were quite helpful in our molding study program, but required appreciable maintenance and still are under study. The difficulties encountered here have been due mainly to the close fit of the gaging plunger in the nozzle (about 0.001-inch diametral clearance), and failure of lead wires for various reasons. Because of this, we are continuing the investigation of available commercial gages for this service, but as yet have not found any with the desired reliability nor the adaptability of our design.

Conclusions

With suitable equipment for measurement of melt pressures both at the nozzle and in the mold cavity, the cause of difficulties encountered by the injection molder should be apparent more readily and trouble-shooting simplified. We believe that use of accurate pressure transducers will lead also to better design of both molds and injection molding machines, as well as the formulation of plastics with better molding properties. It is hoped that both mold and nozzle pressure gages suitable for routine commercial use will become available. If and when they do, the molder will gain better control of his production.

—THE END



Experimental shelters at Illinois Institute of Technology are shaped like hyperbolic parabaloids and sprayed with quick-drying vinyl plastisols.

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Colorants for Plastics

A review, based on experience, of yellow, orange, red, green, blue, and violet pigments for plastics.

IT is the object of this article to review, in the light of experience, the color pigments used in plastics. It is not possible to state categorically that "X" pigment can or cannot be used in resin "A," since there are no established criteria of performance other than "the customer shall be satisfied."

It is possible, however, to discuss separately the color areas of yellow, orange, red, green, and blue; evaluate the available colors in general terms; and show why some pigment would be preferred in a particular resin for a particular job. Since there are no "absolute" judgements possible, the opinions expressed here are relative to our own experience.

There are several means of coloring plastics: (1) by internal coloring (the use of dispersed and insoluble pigments, and by the use of soluble dyes); or (2) by coating (over-spraying, dip-dying, or vacuum-metallizing). We will consider only internal coloring by the use of insoluble chemical colors, either organic or inorganic. The mechanics of dispersing these colors in the resins will not be discussed here, since this is a separate subject in itself.

Table 1 briefly outlines the comparative advantages of pigments (the insoluble colors) and dyes.

Restricting this paper to the pigments, we would like to offer a thought that is axiomatic among pigment makers: No pigment is good for every job, but all pigments are good for particular jobs. This statement has proved true for the plastics-coloring field where there are many resins to be colored and many pigments to choose from, any one of which may do a special job very well. There exist, however, a few fundamental requirements for colors in plastics which can eliminate many pigments and leave us with a more manageable group to consider. The basic requirements are heat stability, light stability, dispersibility and insolubility.

Color Classes

By these initial qualifications, we can eliminate many pigments such as PTA Greens and Blues, Lithol Reds, the anilide Benzidine Yellows and Rhodamines, and others. What we have left, in terms of general classes of colors, are oxides of metals such as titanium and iron; Cadmium Yellows and Oranges; Selenide Reds; Mercury-Cadmium colors; BON Reds; a few Azo Reds; "Vat" Yellows, Oranges, Reds, and Maroons; and the Phthalocyanine Blues and Greens. We also have a relatively good group of inorganic chromates, such as Lead Chromates, Strontium Chromate, and Molybdate-Chrome Orange. If properly made, these colors possess at least the minimum heat-stability, lightfastness, insolubility, and ease of dispersion.

Table 1. Comparative Advantages of Pigments and Dyes.

Pigments	Dyes
(1) More light-fast than dyes.	(1) Usually less expensive than pigments.
(2) Do not crock or bleed when selected properly.	(2) Easily and uniformly incorporated.
(3) Capable of long heat histories.	(3) Provide brilliant colors often unobtainable with pigments.
(4) Produce opacity easily, when desirable.	

We can consider these chemical color groups and specify their particular properties, thus qualifying their use in the larger classes of resins.

Yellows

In this group, there are Cadmium Yellows (including Cadmium Lithopone and Toners), Chrome Yellows, Strontium Yellows, Vat Yellow GP (Color Index 1118), Iron Oxide Yellow, and Benzidine Yellow.

CADMIUM YELLOWS. These are suitable for all thermosetting and thermoplastic resins. They are heat-stable to 600-700° F., and are light-fast and alkali-fast. Their dispersibility is good for dry-tumbling or Banburying in hard resins, and for making plasticizer pastes of vinyl plastisols. Water-based dispersions are useful today in the three-component systems for polyurethane foams. The water sensitiviy which makes Cadmium Yellow fail during exterior exposure in paint films is not a problem with acrylics, styrenes, vinyls, and polyethylene where the small percentage of pigment content is protected by a water-resistant resin. Only in some cellulose-sponge applications do water and certain residual-acid chemicals combine to affect Cadmium Yellow adversely.

Two properties which Cadmium Yellows lack are transparency and high tinting strength. There is no yellow pigment of equivalent light-fastness which will offer transparency. In pigmenting synthetic monofilament yarns, the lack of tinting strength is a serious drawback, since the percentage of color which can be incorporated into the yarns is strictly limited (at the top limit, Cadmium Yellows produce only pale, washed-out colors). Whenever the percent content of pigment must be kept at the lowest point for needed clarity or surface polish, the choice between pure and Toner-type Cadmium Yellows and Lithopone (reduced color) Yellows is always for the pure type. The pure Cadmium Yellows have about twice the coloring power of the Toner and Lithopone Types, and can show superior dispersion (because of special surface treatment) with hard resins which often are colored by dry tumbling before molding.

CHROME YELLOWS. Chrome Yellows are almost exactly equivalent in mass-color, tint shades, and tinting strength to the pure types of Cadmium Yellows, but are rather sharply limited in use by lack of heat stability. Since many of the thermoset resins require temperatures in excess of 350° F., and thermoplastics such as styrenes, acrylics, and nylon require or often use even higher temperatures, Chrome Yellows are used safely only below 350° F. and for limited heat histories. The big usage for Chrome Yellow is in vinyl plastisols, resins, vinyl sheeting or film, and vinyl garden hose. The low processing temperatures of polyethylene also safely accommodate the chromes.

The Chrome Yellows, which suffer from rather severe darkening in paint films, have much better color-retention in plastic resins owing to the lower reactivity of the resins with the lead chromate. If the resin has innately good color-retention and is non-reactive, a Chrome Yellow will show color retention that is nearly on a par with that of Cadmium Yellow.

Chrome Yellows are not alkali resistant; showing considerable change of shade to a dirty orange in the presence of active alkali. For this reason, they are not used widely in heavily-filled vinyl tile, or in systems where the extender pigment causes more permeability. In rubber, Chrome Yellows show reaction with sulfur, turning black by forming lead sulfide. This reaction can be avoided by use of alternate agents where the sulfur is "tied up" (as in Thiurams), by using aromatic peroxides as curing agents.

A recent addition to the Chrome Yellow family is a special "Yellow for Green" or "shading" yellow. This is a light yellow of superior light-fastness and strength. It is designed primarily to give brilliant greens when blended with Phthalocyanine Blues and Greens, but can be used either alone or with white pigments. "Yellow for Green" has found a broad usage in opaque vinyl hose and other vinyl compounds.

STRONTIUM YELLOW. Strontium Chromate is perhaps a less well known chromate pigment, but has found a deserved place in pigmentation of vinyls, certain synthetic rubbers, and natural rubber. Containing no lead, it does not blacken in sulfur-cured rubbers. It is very lightfast and has exceptional heat stability, considerably better than that of the lead chromates. Its widest use is in vinyl compounds where it serves two purposes; (1)it is a very light "primrose" color of good permanence, and (2) its strontium content actually acts to help stabilize vinyl from normal degradation due to heat or ultra-violet exposure.

The draw-back which has tended to limit use is its low tinting strength. Strontium Chromate has about one-half the tinting strength of Chrome Yellow, and is slightly more expensive. Kentucky Color pioneered its use, and produces a special grade that is surface-treated for superior dispersing properties in rubber mills and Banburys.

VAT YELLOWS. A class of pigments which has only recently become well known is the group of Vat colors. One of these, a "flavanthrone" Yellow, shows excellent light-fastness, heat stability, and transparency. As it is tried by more and more producers, it probably will be used more and more widely.

Vat Yellow GP, offered by two domestic producers, shows excellent color retention in properly-stabilized vinyls, and in polyesters where excellent transparent

"golds" can be made. Its temperature resistance of up to 450° F. for two hours certainly will find it a place in the coloring of the higher melting-point resins. This Vat Yellow is non-staining and non-bleeding (or non-crocking). Its one deficiency is lack of saturation, being not quite as bright as a Medium Chrome Yellow.

IRON OXIDE YELLOWS. Another group of inorganic yellows are the Iron Oxide Yellows. They are not brilliant, but are light-fast and heat-stable for most uses. The iron content rules them out of vinyl compounds, unless large amounts of stabilizers are included. Their lack of tinging strength limits their use in other resins. However, melamine molding powders, phenolics, and others can make good use of the low cost which is a very attractive feature of the iron oxides.

BENZIDINE YELLOWS. Before leaving the yellows, mention should be made of the fact that there are other organic yellows being employed by the plastics industry. Volume-wise, the largest of these are the Benzidines, expecially the toluidide variety. In the Benzidine series there are colors with satisfactory bleed and dispersibility properties.

The main points of failure for this class are lack of stability at elevated temperatures, and poor light-retention in tints. As colors go, Benzidines possess a high degree of brightness and tinting strength.

HANSA YELLOWS. Hansa Yellows play minor roles, principally because of the same deficiencies as the Benzidines, plus poor bleed or migration properties in materials such as vinyls.

Oranges

Among the orange pigments are Cadmium Orange, Molybdate Orange, Vat Orange, and Benzidine Orange. There are fewer orange pigments than there are yellows suitable for plastics.

CADMIUM ORANGE. The Cadmium Oranges are the quality pigments in this color range. They are quite similar chemically to the Cadmium Yellows, but contain a small percentage of selenium (which gives the redder color) or mercury (which can be used to replace selenium). These colors are practically equivalent, in most respects, whether given the "red" shade with selenium or with mercury. They are heat stable, light-fast, and alkali-fast, and have excellent opacity.

Owing to the lower cost of mercury, the Mercury-Cadmium Oranges show signs of replacing the selenide colors for many applications. Both types can be used in all plastic resins with safety and assured color retention.

MOLYBDATE ORANGE. Molybdate Orange is a lead chromate-lead molybdate complex crystal. It has all the features of lead chromate, plus exceptional brilliance and tinting strength. Molybdate Orange is more light-fast than Chrome Yellow, but is not as light-fast as Cadmium Orange. While heat stable enough for vinyl, Molybdate Orange is used only rarely in styrenes (except for very low cost "throw-away" items) in acrylics, butyrates, or melamine because of excessive browning with long or high heat histories. Molybdate Orange is somewhat sensitive to small amounts of alkalies, therefore cannot be used safely in plastic floor tile or coverings unless the compounds have very low filler contents. It is used in asphalt tile where quality demands are not so rigid. This pigment can be used in rubber with the same special curing agents as for lead chromates.

VAT ORANGES. It might be well to mention some organic oranges which are in small usage, but may offer interesting possibilities. One organic group is the vat oranges which, like flavanthrone yellow, are relative new-comers to plastics coloring, due to the small production (limited to two suppliers, and output directed principally to automotive finishes).

As chemical compounds, the permanent vats for plastics are the halogenated anthanthrones, pyranthrones, and imidizoles. They are useful for producing very light-fast pastel shades that are considerably more brilliant than can be made with Cadmium Oranges and Light Reds. Another valuable property is the transparency of the vat colors; used in clear systems, they offer permanent translucent and transparent golds, rich ambers, and oranges. Having excellent heat stability, these oranges are usable in a wide variety of thermoplastic and thermo-setting resins.

Kentucky Color recently has introduced eight vat pigments of which five are light to deep oranges called "Century Colors."

BENZIDINE ORANGE. With the exception of the vat oranges, the Benzidine Oranges are about the only organics being used today by the plastics industry. Their main advantages and disadvantages are those encountered with Benzidine Yellows.

Reds

The reds for plastics probably are the most numerous group, and include Cadmium Reds (Selenides and Mercurides), Azo Reds (Red 2-B, Rubines, Pyrazolone, Pigment Scarlets, and Naphthols), Vat Reds, Red Iron Oxides, Molybdate Orange-Maroon combinations, and Thio-Indigo Maroons.

CADMIUM REDS. The Cadmium Selenide Reds in pure and lithopone forms have been mainstays of plastic coloring, in that they are versatile pigments. They have the heat-, light-, and chemical-stabilities encountered with other colorant systems. Only Permanent Red 2-B, an organic red, even threatens their number one quality position. Cadmium Reds were solely made once as artist colors and for ceramics. When plastic resins demanded high temperature resistance and extreme light-fastness, Cadmiums were drafted for this use. The dispersion properties were greatly improved by careful selection of surface agents, and the Cadmium Reds were steadily upgraded in mass-color brightness by newly-found techniques of calcining.

One great difficulty has plagued the makers and cosumers of Cadmium Reds; the erratic supply of selenium, which was absolutely necessary. This metal was suddenly in demand for electronic equipment in larger quantities and at higher prices. This sent prices for Selenide-Red (with 5-25% selenium content) soaring, and, at times, has caused some users to shift to other reds where possible. An answer to the selenium shortage has been offered by certain color makers who have developed Mercury-Cadmiums which substitute mercury for selenium. All plastics colorers are carefully

testing this new Mercury-Cadmium pigment. We believe it to compare very favorably with the Selenide type, and to offer welcome economies. A few manufacturers are presently making Mercury-Cadmium Reds in the light red-to-maroon range in both concentrated and reduced (40%) forms.

AZO REDS. Permanent Red 2-B, an organic red made by coupling 2-B acid with betaoxy naphthoic acid and precipitating the results with calcium, is a very useful and popular plastics red. It is very brilliant; is heat-stable to 380° or 400° F. for short (five-minute) cycles; and has great tinting strength relative to its cost. In comparison, Cadmium Reds (100% type) have only one-fifth the tinting strength). Their ability to absorb modest heat cycles, their low cost, and their non-crocking quality have made Red 2-B very popular for medium-quality vinyl sheeting, vinyl hose, rubber goods of all types, styrenes, acrylics, acetate yarns, and many other areas.

Red 2-B has one major failing; lack of light-fastness when diluted with more opaque pigments. There are one or two BON couplings, however, which offer some improvement in light-fastness. The Rubines laked with calcium or strontium are better in light-fastness, but are weaker and less "clean" in shade form. A manganese lake of 2-B also is superior in light-fastness, but the manganese may be objectionable for polyvinyl chloride because it catalyzes break-down of the resin. To use this superior type of 2-B, therefore, each compounder should carefully evaluate his particular system.

Other organic reds have found some use with special resins. The most important of these from the commercial viewpoint is Pyrazolone Red. There are two varieties of Pyrazolone; the $4.60-per-pound type with very good light-fastness in full shade, and the $3.60-per-pound type with poor light-stability but very high dielectric strength in vinyl wire insulation. Pyrazolone with good light-fastness in full shades and as a transparent is the carbethoxy coupling. While heat-stability is good, some care should be exercised if heat cycles are long. Pyrazolone's deficiency is poor color-retention when diluted with opaque pigments such as titanium dioxide and others.

Pyrazolone has a beautiful yellow undertone, and makes handsome transparents in styrenes, vinylidine chlorides, acrylics, and polyesters. One popular application for Pyrazolone is vinyl floor tile, when it is chosen for its color in deep shades, and its general chemical resistance (particularly soap resistance)*.

The Naphthols are another class of Azo colorant. These colors are soluble with primary and other plasticizers used in vinyl; consequently, they crock badly in flexible stocks if the content of color is ½% thereabouts. Their chief advantages are wide color range, low cost, and soap resistance (again for vinyl tile usage). They are used only rarely in other than vinyl resins.

Pigment Scarlet, another Azo color, is valuable mainly to users of polyvinyl chloride. This pigment is good in non-bleeding properties, and is one of the better Azos color retention. In shade, Pigment Scarlet is a blue undertone red, and is a lower-cost replacement for Red 2-B.

*The BON Reds fail rather quickly when subjected to soap, if the resin is heavily filled.

VAT REDS. Like the Yellows and Oranges, the Vat Reds are specially-selected colors having light-fastness and brightness of a high order. They are not used widely as yet in the plastics field. Owing to their relatively high cost, they are used where quality is the primary factor, and where brightness of the required color cannot be obtained with a Cadmium Red.

The Vats also have nice transparency, and produce handsome "clear" colors. Objects like automobile taillights which appear to be dyed, often have "clear" pigmented lacquers as a coating on the reverse side. The same "clear" colors also can be obtained with the Vats, using these pigments dispersed internally in styrene, acrylic, melamine, vinyl, or polyester resins.

Molybdate Orange can be used as a cost-reducer when mixed with the more expensive reds, and holds its own in light-fastness. There are several shades of Molybdate Orange; the light, very bright shade (with good tinting strength), and the dark, redder types (with better permanence and weaker, bluer tints). These latter more permanent types achieve a double result when blended with reds; a higher percentage of them can be added to a red without making the resultant color appear overly "yellow", and the bluer undertone produces cleaner blends. The quality of the resultant blend is determined largely by the organic red used.

The shade range of these reds, of course, can extend all the way from Red Lake "C" through Red 2-B to thio-indigo vat reds. The resultant color of Molybdate Orange-Organic Red blends has a high order of brightness. The mixed colors are used in vinyls, rubbers, low-cost styrenes, polyester gel coats, and some cellulose materials.

MOLYBDATE ORANGE-MAROON. Looking back for a moment at our comments on Molybdate Orange and its good durability, particularly in tints, we recommend "reddening" the Molybdate with a permanent red colorant like the vat reds to assure light-fastness, and using the Molybdate to reduce the total cost. Another suggested use for the Indanthrene Reds is in polychromatic or metallic colors in combination with aluminum flake. These metallic colors are popular in supported vinyl for use in automotive upholstery and furniture. Since this application demands transparency together with exceptional light-fastness, the vat colors are made to order for these requirements.

THIO-IDIGO MAROONS. Thio-indigo maroons based on insoluble dyes, such as Permanent Violet RH and its chlorinated derivatives, are finding increasing usage in various plastics. Regular maroons tend to be very bluish in tint tones, while the chlorinated types are lighter and redder in mass color and yellower in tints. These colors have excellent strength, and are moderately priced when considering their strengths. These colors are used often in auto-body enamels in combination with Molybdate Orange, and the same can be done successfully in many plastic resins, except those resins processed at temperatures which discolor the Molybdate excessively. Since the thio-indigo maroons and deep reds are not stable in all vinyl and vinylidene chloride systems, particular attention should be placed on the selection of stabilizers, and all colors should be checked for durability under exposure conditions.

RED IRON OXIDES. Red Iron Oxides are heat-stable

(being roasted Yellow Oxides), alkali-fast, and permanent to light, but are somewhat limited in usage by their lack of brightness. Being low in cost, it would be highly desirable if only a few extra degrees of brightness were available. Due to the iron present, however, these oxides can be troublesome in vinyls, unless carefully stabilized. Their greatest usage quantity-wise is in the rubber field. Although they have limitations, being low in brightness and low in tinting strength, I believe that much more can be done with these colors by thoughtful formulators in a wide group of resins.

Greens

The green pigments for plastics are not too numerous, and are Phthalocyanine Green, Pigment Green B, Chromium Oxide, and Yellow-Blue Mixes.

PHTHALOCYANINE GREEN. The utility of Phthalocyanine Green far overshadows all other available green pigments, since it does everything well. There is no plastic resin today which does not depend largely on this color for brilliant, heat-stable, non-migratory, transparent, and light-fast deep colors and pale tints. Although expensive a few years ago, the cost is being reduced gradually. One improvement made recently is the fully-chlorinated variety that is considerably yellower in undertone, and richer and without haze in transparents. This newest type also shows better dispersion.

PIGMENT GREEN B. This green is an organic naphthol salt that finds wide usage in many plastics where an olive-green color is desired. It is very good in resistance to alkalies and soaps, and for this reason is used in floor coverings made of various plastic resins. Pigment Green B has good bleed resistance, except to ketones, and is satisfactorily non-migratory in vinyl. This color has great tinting strength, and is attractive because of its low cost. A characteristic of this color, which formulators should keep in mind, is its poor light-fastness in pale tints (not more than 20-30% Titanium Dioxide can be mixed with it safely), for deep colors, however, it is excellent. The rubber industry has made good use of Pigment Green B properties.

CHROMIUM OXIDE. The inorganic Chromium Oxides, both regular and hydrated, still are being used, although largely displaced by Phthalocyanine Green. The rubber trade uses a considerable quantity of regular Chromium Oxide, as do some flooring manufacturers.

YELLOW-BLUE MIXES. The yellow-blue mixes can be made with any of the following: Chrome Yellow, Cadmium Yellow, Benzidine, and Strontium Yellow plus Phthalocyanine Blue. Phthalocyanine Green, of course, can be added too, and frequently is. In these mixes, the yellow component generally establishes the quality of the colorant in the specific resin, since the Phthalocyanines are satisfactory in every way.

Blues and Violets

The blue and violet colors can be covered in one section, since usable colors are not too numerous. They include Phthalocyanine Blue, Ultramarine Blue (poor acid resistance), Iron Blue, Manganese Violet-Rubine Lake FF, and Dioxane Carbazole Violet.

PHTHALOCYANINE BLUE. Like its chlorinated twin the green, Phthalocyanine Blue is the chief blue used in plastics. In all but one respect, it does everything as well as Phthalocyanine Green; the Blue is not as heat-stable. It is used carefully in resins that demand repeated heat cycles above 350° F. Heat failure shows as a serious shift in color to the greenish hue. This shift can be partially compensated for by slightly chlorinating the blue and changing it in advance to the greenish side. After this chemical shift, it is less affected by high temperatures.

Because all dark colors such as blues, greens, and blacks contrast greatly with white compounds, dispersibility is of prime importance so that no specks appear in molded sections (wall-tile, for instance), and no smears in extruded sections. Although the consumer will not find appreciable variation between sources of Phthalocyanine Blue with regard to permanence, heat-stability, and chemical resistance, the dispersion characteristic is a distinctly variable factor. The best plastic blues are especially surface-treated for dry tumbling dispersion and better general working properties.

ULTRAMARINE BLUE. As a color, Ultramarine Blue has a redness and brilliance that is difficult, if not impossible, to reproduce with other pigments in plastics. Being a calcined pigment at 1,500° F., this blue has ample heat-stability. There are some possible reactions, however, of the small free-sulfur content of Ultramarine with the lead stabilizers of vinyls. This reaction produces free acid that in turn, attacks the blue itself. Special "acid-resistant" blues should be used in these cases. Light-stability of Ultramarine is excellent.

The principal disadvantages of this color are low tinting strength, and excessive transparency. Recently, some "super-strength" Blues of the green-tone have been offered to correct this defect. It should be kept in mind that special grades of Ultramarine Blue are produced with superior dispersion properties in plastics resins. These can be added directly in Banbury mixes without masterbatching.

IRON BLUE. Ferri-Ferro Cyanide, or Iron Blue, is a pigment that has been taking a back seat to Phthalocyanine Blue in plastics. This low-cost blue pigment has never been easy to disperse in plastics resins; is very sensitive to alkalies; and is inferior to Phthalocyanine Blue in tint-color retention. The only logical place for Iron Blue to replace Phthalocyanine Blue, therefore, is in deep-tone blue shades. Only where the blue content is high is the cost differential of any real significance. Lately, however, the discovery that Phthalocyanine Blue seriously inhibited the conversion of polyester resins has caused users of these resins to test other blue pigments. Iron Blue works successfully in polyesters and, in addition to Ultramarine Blue, probably will be used in this resin group for some time.

MANGANESE VIOLET. The violet colors have not been very popular style-wise, but a good permanent violet for tinting blues to the reddish cast, and for pale lavenders and "iris" shades, has been necessary. The pigment that most generally has answered most demands is Manganese Violet, a manganese pyro-phosphate. Despite its manganese content, it has not proved injurious to vinyls. This violet is heat-stable to approximately 550-600° F. Its drawbacks are very low tinting strength, and a crystallinity that sometimes causes

Table 2. Relative Lightfastness of Pigments for General Plastics Usage (Based on One-Year Exposure Tests in South Florida).

	Mass Color, 100%	Combined with TiO_2 50:50	Combined with TiO_2 10:90
YELLOW:			
Cadmium Yellow	Excel.	Excel.	Excel.
Nickel-Titanium Yellow	Excel.	Excel.	Excel.
Vat Yellow GP	Excel.	Excel.	Excel.
Iron Oxide Yellow	Excel.	Excel.	Excel.
Benzidine Yellow	Excel.	Satis.	Poor
Chrome Yellow	Satis.	Satis.	Satis.
Strontium Yellow	Satis.	Satis.	Satis.
ORANGE:			
Cadmium Orange	Excel.	Excel.	Excel.
Mercury-Cadmium Orange	Excel.	Excel.	Excel.
Vat Orange	Excel.	Excel.	Excel.
Molybdate Orange	Satis.	Satis.	Satis.
Benzidine Orange	Satis.	Poor	Poor
RED:			
Cadmium Selenide Reds	Excel.	Excel.	Excel.
Pyrazolone Reds	Excel.	Poor	Poor
Molybdate Orange-Thio Red	Excel.	Excel.	Satis.
Vat Reds	Excel.	Excel.	Excel.
Iron Oxide Red	Excel.	Excel.	Excel.
Rubine-BON	Excel.	Satis.	Satis.
Mercury-Cadmium Reds	Satis.	Satis.	Satis.
Permanent Red 2-B	Satis.	Poor	Poor
Red Lake C	Poor	Poor	Poor
Lithol Red	Poor	Poor	Poor
Pigment Scarlet	Poor	Poor	Poor
GREEN:			
Phthalocyanine Green	Excel.	Excel.	Excel.
Chromium Oxide Green	Excel.	Excel.	Excel.
Phthalocyanine Blue-Cadimum Yellow	Excel.	Excel.	Excel.
Pigment Green B	Excel.	Poor	Poor
Phthalocyanine Blue-Chrome Yellow	Satis.	Satis.	Satis.
Phthalocyanine Blue-Strontium Yellow	Satis.	Satis.	Satis.
Phthalocyanine Blue-Benzidine Yellow	Poor	Poor	Poor
Phthalocyanine Green-Chrome Yellow	Satis.	Satis.	Satis.
BLUE:			
Phthalocyanine Blue	Excel.	Excel.	Excel.
Ultramarine Blue	Excel.	Excel.	Excel.
Indanthrene Blue	Excel.	Excel.	Excel.
Iron Blue	Excel.	Satis.	Poor
VIOLET:			
Carbazole Violet	Excel.	Excel.	Satis.
Alizarine 6 BL	Excel.	Poor	Poor
Manganese Violet	Excel.	Excel.	Excel.

erratic or poor dispersion.

For vinyl use and some styrene applications, a strong reddish-violet has been sought. One laked and insoluble pigment-dye has been found quite satisfactory; a lake of Helio Rubine (blue shade). This color is too bluish to be classified as a red and, therefore, is included in this section. For a color of its type, it has unusually good heat-stability.

VAT VIOLET. Dioxazine carbazole violet is a vat pigment with excellent resistance to light, heat, and chemicals. It is not used too widely because it is expensive, but its superior properties should recommend it wherever quality is important.

Summary and Conclusions

On the basis of experience, we have presented a discussion of colorants for yellow, orange, red, green, blue, and violet colors in plastics usage.

A relative comparision of pigments as to their lightfastness for general plastics usage is shown in Table 2, based on exposure data obtained in South Florida. The tabulated comparison is shown for three conditions: 100% Mass Tone; and for both 50:50 and 10:90 combinations of the color with titanium dioxide. The comparison given in this Table is expected to have more general or wider meaning for users of colorants than a comparison based on some specific facet of color that would apply only to specific use in a certain resin.

As new plastic resins are offered, each has its pigmentation problems. Many of the yellow, orange, red, green, blue, and violet pigments mentioned above will be modified to meet special conditions, and some new colors may be developed. The chemical efforts of the resin and colorant industries will combine to create colors for decorative, aesthetic, and sales appeal.

—THE END

Helping The Customer To Grow

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THE plastics industry has its eye firmly fixed on 1960—a year which prophets say will bring production up to six billion pounds, an increase of almost 50 per cent over 1956. The prospect is alluring, carrying with it a vision of new plants, expanded product lines, and increased profits.

Some industry observers foster the habit of star-gazing, speculating too much on the dramatic new products which plastics may make possible within a decade. Plastics history, with its fantastic record of growth over the past few years, lends itself readily to forecasts of even greater strides for the future.

We yield to no one in our faith in the industry's future but the bright promises of tomorrow can be blinding. Such preoccupation can be dangerous business if it leads to opportunism, and puts a stronger value on short-term individual benefits than on a long range growth of the industry as a whole.

In an industry as dependent upon close working relationships as ours, this could be fatal. Even a temporary lapse in mutual trust and helpfulness among supplier, processor, and end-user could arrest the over-all growth. If collaboration were interrupted altogether, the essential ingredient of product engineering could become a hit-or-miss proposition, and the public would rightly view plastics as cheap substitutes.

Considering the risks involved, it would seem logical that the industry approach its glowing future in an atmosphere of mutual trust and cooperation. Yet, from my 20 years experience in plastics sales work, I know this is not always the rule. The introduction of a new resin can leave the materials supplier with a feeling of helplessness, for instance, if a molder will not permit the resin producer to assist in setting up the special processing conditions which may be necessary. Another case might be where existing resins are running into trouble with a new and difficult mold. Here, the technical help of the materials supplier is refused because the processor regards all but a select few of his own employees as outsiders, and thus a threat to the secrecy of his operations.

The materials supplier does not want to prove that his technology is indispensable and, in truth, it is not. In most cases, the processor is able to solve the problem in his own shop—sooner or later. The processor forgets, however, that the supplier's technologists and laboratory equipment can do the job in less time than by the trial and error techniques which worked so well in the early days of plastics processing. This can mean savings in terms of idle machine time, resins reduced to scrap, and diversion of technical manpower from other projects. The ability to bring new products into production quickly, and without false starts is in the supplier's interest too. Breaks in any part of this chain from raw material to finished product can have harmful effects on the industry as a whole.

To be fully effective, cooperative effort should go beyond processing technology. From my experience I know the mutual interest between supplier and processor is broad, ranging from market analysis to design and new product ideas.

An illustration of how all these elements of marketing can work together is shown by what happened recently when one of the men in our "end use development group" got an idea for an improved control button of "Lucite" acrylic resin. This button would be economical to mold, and would offer an added sales incentive by illuminating the setting dial on a manually regulated appliance. Dimensions of the optical system were calculated by the design staff, molding costs were estimated, and artists' sketches worked into a good presentation. A few buttons were machined and the model shop put them into a facsimile of the appliance.

The "end use group" took the story and model to several appliance makers, accompanied by a line salesman who was able to suggest molders near each appliance maker from whom detailed quotes might be obtained. In all cases we stressed that our study of the economics of the part was a conservative one, and a custom molder should be the man to set price range and work out feasibility of modification.

The idea was well received, and each appliance company modified the design to his own styling. The salesman and technical man of our district office checked the proposed optical system and consulted with the molder on production tools. Result: more business for every company participating in the chain.

In Du Pont, experience has shown that the surest way to grow is to help our customers grow. Indeed, we shall have become a static industry if there is ever a "freeze-up" on dissemination of data and the kind of development requiring corporate resources. Indeed, I'm sure that neither the converter, the material supplier, nor the consuming industry and public want that to happen.

—THE END

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Can Performance Tests Be Developed for Finished Molded Articles?

Current scarcity of design data on plastics is discussed, and a program for data from performance testing is proposed to meet the need.

ONE of the major problems of a chief designer was the education of his young engineers in plastics. Their proposed designs were so bulky, it was evident that they thought of plastics in terms of cheap, inferior metals. When he criticized their work, they asked for design information to help them use the plastic materials properly.

That was a reasonable request, but it pointed up the major problem of the designer, particularly the less-experienced one. The problem is not unique and occurs with all new materials, since judgement of how to use them is based on experience obtained with more familiar materials. A trial-and-error method of operation must suffice until experience has been developed to the point where a "feeling" for a new material can be obtained. This period of apprenticeship with a new material will depend on how radically it differs from those used previously.

Historically, as new materials appeared, the need to describe their performance in order to train personnel finally became acute. Rough methods of evaluation had to be developed. The more experienced persons set down information about article performance requirements they knew. These bits of information were collected eventually and made available generally. The less-experienced could make use of the collected knowledge then, and so become sufficiently familiar with the new material to use it with some degree of effectiveness.

The rapid growth of the plastics industry has brought the art of working with plastics to the point where designers rely mostly on a "feeling" for plastics, since data for design criteria is far from adequate. To make matters worse, new plastic products are appearing at

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increasing frequency, so that the "feeling" becomes more and more difficult to acquire and retain.

Need for Design Data

This means that we, as material suppliers, are placing many obstacles in the path of designers using plastics. Designers will shy away from working in our area where they have only vague knowledge, particularly where they are required to meet a price and accommodate a means of fabrication. If acceptance of plastics is to expand, the engineering properties of the materials must be known under conditions of both normal use and unusual environments. In addition, allowable unit stresses for varying types of loading are needed for engineering the elements standard in common plastic structures.

We know that this maturity on the part of plastics technology has not been reached as yet. For example, we have no data equivalent to steel's coefficient of sliding friction given by 13 separate investigators over a period of 50 years (1)*. We do know, however, that qualitative data on plastics are being gathered.

The most obvious source of information is the data collected by manufacturers of plastics materials. The majority of this work involves physical and chemical testing of molding materials and simple molded shapes. Tests such as average molecular weight, monomer content, and infra-red analysis are carried out for the primary purpose of identifying the plastic material. Tests such as degree of clarity, and heat distortion temperature serve to check adherence of the plastic material to grading specifications at the point of manufacture. Flow and set-up molding tests and Rossi-Peakes flow tests attempt to characterize the conversion variables of the material, primarily to insure that material variability is kept as low as possible.

Other testing performed in the material suppliers' laboratories checks materials against end-user or government specifications, based usually on ASTM test methods. Many of the tests were borrowed from the metals industry and applied to plastics which have a higher sensitivity to speed of loading. Thus, definition of plastics' engineering behavior by these tests is usually not adequate for design purposes. The tests serve mainly to differentiate between polymers and establish quality levels.

The academic and research institute laboratories provide another obvious source of design information on plastics. Among the more active projects are the joint industry-university work performed under the MCA-MIT Plastics Research project, and the SPI-sponsored work at Battelle Institute. The former is involved with research projects on specific problems or areas of interest; some examples are work on relaxation, creep, and stress-strain behavior of plastics materials. One Battelle project is the development of test methods for plastics pipe standards. Both projects provide a variety of information, either general or specific.

Grants-in-aid for fellowships are common, and these investigations can be classed generally as work on well defined applications. Recent contributions have been work on the use of plastics in automobiles and in furniture done at Pratt Institute, and work in plastics for home construction done by MIT. This work is of great

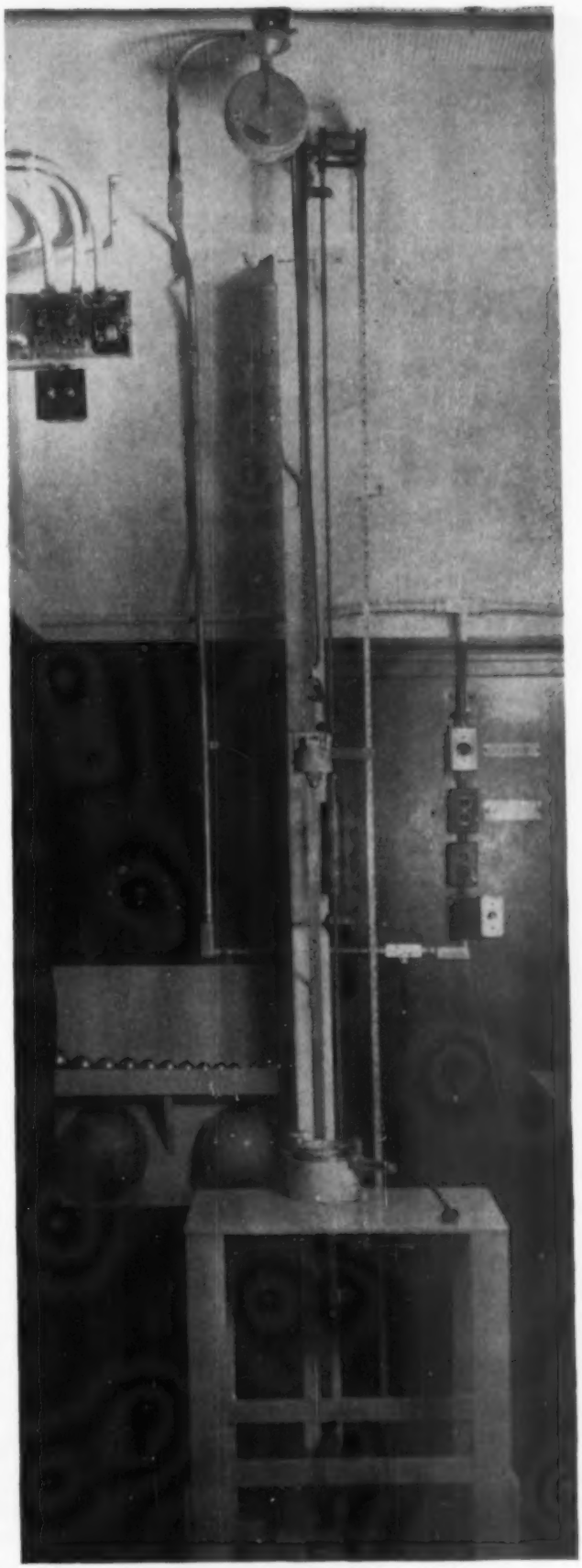

Fig. 1. Ball-drop machine for testing toughness of polyethylene film. A steel ball is dropped onto test specimens from varying heights, and the end point is determined by the appearance of visible cracks.

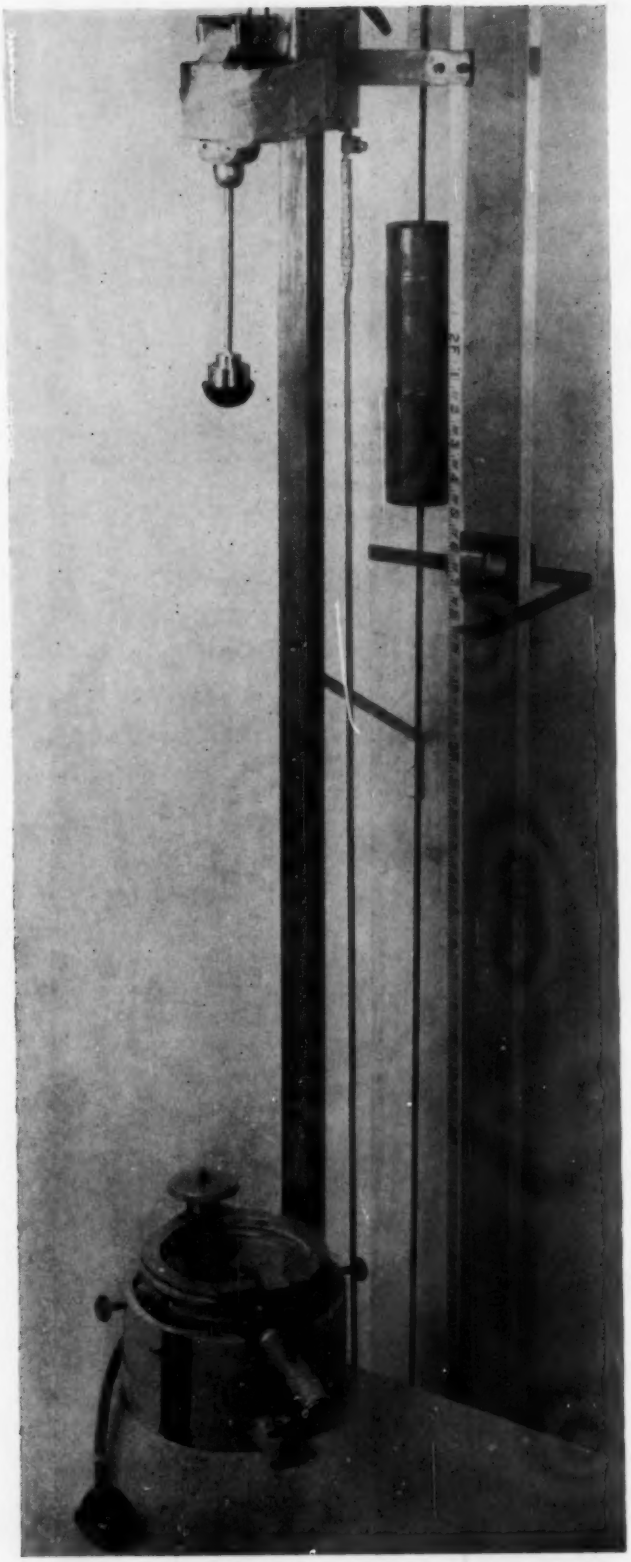

Fig. 2. Dart-drop machine for testing toughness of polyethylene film permits use of different weights for the head, while retaining constant striking-head dimensions.

importance to designers because full-size prototypes are being or have been constructed and evaluated. The methods of handling the problems involved have contributed to the fund of information, so valuable to the design engineer.

An increasing amount of work is being done in the research laboratories of companies using plastics. This includes development of new tests, investigation of the effect of polymer structure on mechanical properties, analysis of stress in viscoelastic materials under strain, and broad characterizations of the properties of plastics. A five-year program on the expected service lives of certain plastics is being conducted by a large refrigeration company. Unfortunately, however, these broad studies and similar work done at government laboratories are not readily useful to the industrial designer because they often are too fundamental for his immediate needs.

Lacking usable data on the mechanical properties of plastics, the designer must fall back on the results of performance tests on the mechanical properties of finished moldings. This is not simple, since there are wide varieties of sizes, shapes, and forms of moldings that necessitate ingenious treatment, often different for the particular applications. In addition, plastics do not act like most other materials of fabrication. The physical properties of steel are predictable and relatively unchanged when steel is introduced as a component in an assembly. Welding, or bolting of steel parts may require some corrective calculations, but the properties of the whole can be predicted essentially from the properties of the parts. Plastics, however, are greatly affected by fabrication techniques, and tests of the finished parts provide the only "proof of the pudding."

If tests of finished molded articles are to be used, a wider variety of test methods must be developed, at least until more adequate information is obtained. There are a few semi-standard tests found in the Commerce Department's Commodity Standards, and in government specifications. These tests, however, usually call for simple stressing under regulated conditions of heat and humidity. Other than some industry drop-testing of assemblies to simulate breakage during shipment or use, there are few other tests for finished goods in wide use.

New Performance Tests

To meet the need, evaluation research groups are experimenting with a wide variety of tests. Some successful work has been carried out at our laboratories with the ball-drop (2) and dart-drop tests (3) (see Figures 1-2). The former consists of dropping a steel ball from varying heights onto test specimens supported by a frame, and the end point is determined by the appearance of visible cracks on the specimen. Investigation into the statistics of destructive testing have provided greater precision for this test (4) and made it a useful tool for estimating the impact resistance of plastic door liners, radio cabinets, containers, etc.

The type and speed of stress application used in the ball-drop test are believed to approximate those usually encountered in actual service. The major advantage of this technique lies in the fact that the finished article is subjected to multiaxial loading, rather than the uniaxial loading inherent in most laboratory plastic testing techniques. Thus, breakage occurs across the lines of orientation (which is the direction of least stress resistance). The effects of orientation, therefore, can be assessed by this technique.

*Numbers in parentheses refer to bibliography at end of article.

Ball drop impact has been correlated with Izod impact tests run on samples cut lengthwise across the major axis of orientation (see Figure 3). Relationship of the ball-drop impact strength to tensile strength and percent elongation at failure also are being studied.

Dart-drop testing has proved successful in evaluating the toughness of polyethylene film. Here, the pronounced effect of the diameter of the dropping weight caused use of a dart where weight could be changed while retaining dimensions constant for the striking head. Reproducibility is good over a wide range of resins and toughness levels. This work can be expanded to compare the effects of handling, printing, storage, etc. When sufficient data on performance in actual use versus dart impact strength is obtained, specifications for levels of toughness to meet specific end-use requirements can be made.

Testing in the container field has been centered around impact testing. Promising test methods, here, are the ball-drop, pendulum impact, and shear tests. The pendulum and shear tests have been used to evaluate plastic wall tile designs. Burst strength tests also are being studied. Correlation of these performance tests with actual service use has not been great as yet, possibly because of the newness of plastics in the containers field.

Future of Performance Testing

It is our belief that some performance tests can be developed with presently available knowledge to assist the molder in his quality control program. Care must be taken, however, to make sure that the tests are reproducible and actually do measure the properties that they are intended to measure. If possible, a test should simulate the finished product's service requirements. Even if the test only involves throwing the part against a wall, it is a good test if it helps the molder. These tests, however, are not good enough for the designer because they involve costly trial-and-error methods. A more sophisticated approach is needed for the designer if he is to obtain the desired results with a reasonable degree of reliability.

To meet this need, work is being undertaken on defining the effects of fabrication on performance for a given product and design. Tests are being carried out to determine the effect of such phenomena as orientation and weld lines on resistance to shock loading, creep, etc. It is believed that this work will furnish information of a continuing value since it will be applicable to all new polymers, and will not be limited only to current products. It will help in obtaining sufficient data for the designer to specify to some extent, at least, minimum safe design limits for satisfactory performance.

Conclusions

The most urgent need is for the solution to the problem of compiling and assessing information which we do not have. A step in this direction is the engineering properties section of the MCA book for 1957, "Technical Data on Plastics." A. G. H. Dietz, of MIT, has given data on plastics and detailed the usefulness of the information to the engineer. However, the problem

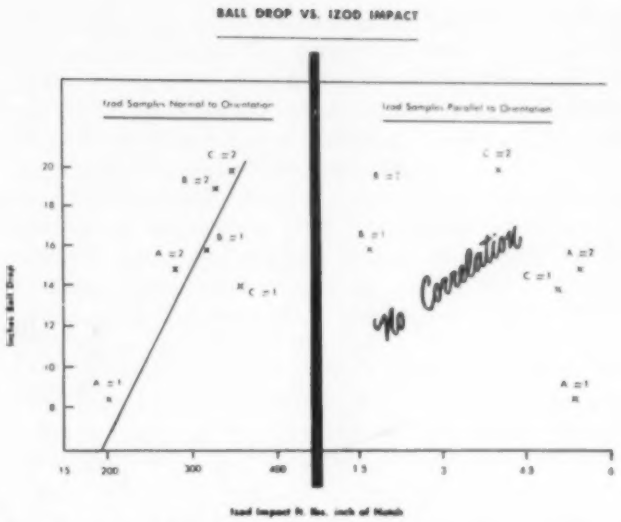

Fig. 3. Relationship of ball-drop impact with Izod impact values of film samples cut perpendicular to major axis of orientation.

is so large and so urgent that either some agency within the industry or a plastics engineering society must begin to analyze the vast stores of data available. They must classify each fragment of information according to type, and judge whether it is identification data or engineering data and, if so, how it relates to performance of plastics. Then, the data must be tabulated and interrelated. Information on plastics that are no longer produced, and obsolete data on currently-made products must be culled out.

It is realized that, even then, we will have only a skeleton of the shape we need. It is upon this which we will have to build, and further data must be added to this framework. A major portion of the job will be determining where each piece of data belongs. As it now stands, the pile of unrelated information is growing, and the difficulty of beginning the job grows with it. We sorely need a positive program for developing a handbook of plastic design. The time is too short for the plastics industry to allow this work to lag, if continued healthy growth is to be stimulated and insured.

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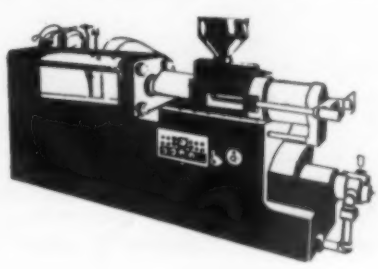

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Molding–Finish Interactions in Fatigue of Glass–Reinforced Polyester Resins

Report of an investigation of the effect of various finishes and cure cycle speeds on laminate properties.

THE increased use of reinforced plastics for structural purposes in industrial applications necessitates a knowledge of their mechanical properties under dynamic conditions. Good design is never based on one-cycle breaking stress because structures seldom, if ever, fail in this manner under normal use. Failure may occur when small stresses are imposed repeatedly, unless these stresses are smaller in magnitude than the fatigue limit of the material. Not only does the design engineer need to know this smaller stress in computing safe working limits for the materials at his disposal, but there is also a need for studies leading to the development of improved resins, finishes, and fabricating techniques.

The successful use of reinforced plastics in critical structural applications will require three kinds of information which at present are limited. (1)**. These are: (a) a suitable mathematical description from which stresses can be calculated for use in engineering design; (b) accurately determined elastic constants for the resins and the filler (for use in conjunction with the preceding); and (c) determination of usable strengths by means of fatigue, creep, and stress rupture.

At least as important as these is the study, by fatigue or other dynamic tests, of the factors limiting the achievement of a theoretically obtainable maximum strength. It is this phase of the problem which is discussed in this paper.

In the development of high strength glass-filled plastic laminates, three approaches were outlined by Erickson and Silver (2). These are (1) the improvement of the glass fiber itself; (2) improvement of the resin; and (3) development of better adhesion between the glass and resin. As is well known, the strength of the laminate depends on the ability of the resin to transfer the imposed load to the stiffer and stronger glass fibers. Obviously, the stresses occurring at the resin-glass interface will play an important role in this respect.

Dietz (3) has described good adhesion as one of the major problems to be faced for improving reinforced

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**Numbers in parentheses refer to bibliography at end of article.

plastics. Good adhesion is not always describable in terms of the strength of the bonds at the interface. Should the bond be stiff, strong, and brittle (such as from chemical linkage) or should it possess a fair degree of stiffness and strength and yet be ductile (reflecting more the influence of non-valence bonding)? What should be its creep and relaxation properties? The answers to these questions depend not only on the end-use of the material, but also on the thermal expansions of the resin and glass, and the shrinkage behavior of the resin during cure. Both of these factors affect the tendency to relative motion between resin and glass and the rate at which this motion would occur.

The enhancement of chemical bonding may not be the sole purpose of a finish. The finish may provide a layer capable of deforming as the shrinkage occurs and as the structure cools from the curing temperature. Stresses at the interface could be relaxed in this manner, thus preventing rupture of the bonds. Rheology of the finish could be an important factor in the development of improved laminates.

Purpose of Test

Specifically, it was desired to study the factors limiting the achievement of maximum strength. Constant-stress flexural fatigue data were examined along with static flexural strength and modulus, damping, and dynamic modulus measurements to learn the benefits to be derived from the use of various finishes and different curing cycles. Hypotheses have been suggested regarding the way in which finishes and cures affect the fatigue and other mechanical properties of the laminates studied.

It is not intended to theorize on the mechanism of attachment of the finish to the glass and resin, nor to postulate regarding the chemical structure of the bonds. The attempt has been to describe properties of the bond and finish (stiffness, strength, and non-elastic behavior) in a qualitative manner, based on the mechanical properties found for the laminates. Suggestions have been made to explain how and why these bonds are disrupted.

Materials and Preparation

One type of glass cloth, ECC-181, was used in this investigation. It has an eight-harness satin weave and approximately the same strengths in both the warp and fill directions. Three different finishes had been applied to this cloth: #V12, a heat-cleaning treatment; #136, a vinyl silane finish; and #114, a methacrylate-chrome complex finish.

Laminates were prepared by successively saturating 12 plies of this cloth with Laminac*** Resin 4123, a medium-reactive polyester type adjusted to a styrene content of 40%. Two curing cycles were studied: (a) a fast cure accomplished in ½-hour at 105° C.; and (b) a slow cure comprising an 18-hour gel and initial cure period at 25° C., followed by a final curing period of one hour at 120° C.

In the fast cure, the resin was catalyzed with 0.5% of benzoyl peroxide (introduced from a 50% tricresyl phosphate paste). The catalyst system used for the resin in the slow cure was adjusted to include 0.25% of a 60% methyl ethyl ketone peroxide catalyst, 0.008% cobalt metal (as cobalt naphthenate), and the 0.5% benzoyl peroxide used in the fast cure.

The saturated assembly was placed between two sheets of cellophane with an overlap of about 12 inches. Starting from the center, all entrapped air bubbles were carefully worked out by hand. In both cures, the assembly was molded to stops (⅛-inch shims) at a pressure of 30 psi.

The effect of each finish was studied under both the fast and slow curing cycles, comprising six kinds of laminates in all. Throughout this paper, the fast and slow cures will be referred to by the letters "F" and "S", respectively. The numbers V12, 114, and 136 will identify the finish. For example, a laminate made of glass cloth having a chrome-complex type finish (114) and cured slowly will be designated S-114.

Glass-cloth laminates generally require hand lay-ups, but the associated human variables are found to produce a highly variable product. This fact should be recognized in studying the data presented. Differences, where claimed have been found to be statistically sound. However, because of the number of tests used in this work and the amount of samples required, it was impossible to conduct all the tests on one laminate.

Inter-laminate variability, recognized to be high, imposes limitations in describing physical behavior, even though the methods of measurement may be precise. The need for reducing these variations should be recognized if two objectives are to be gained. The first objective is to make studies of this nature more sound and, thus, aid in the development of better resins and

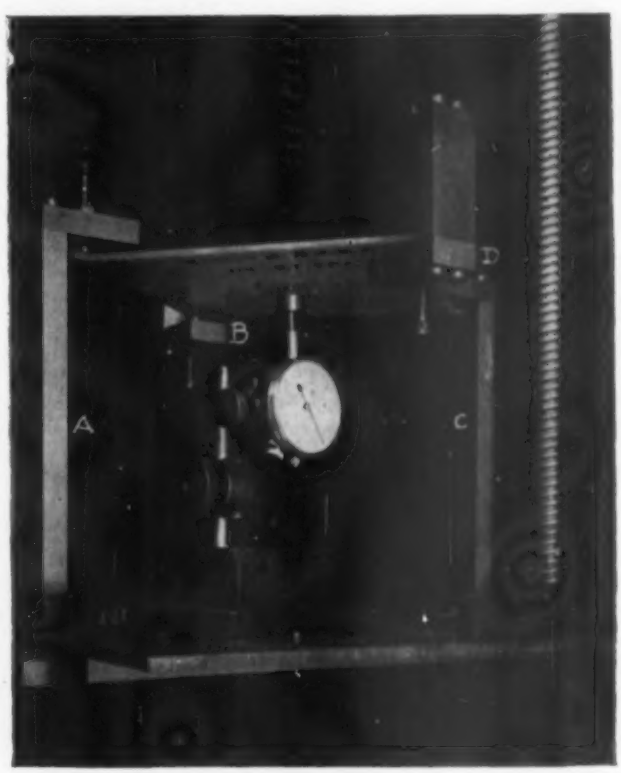

Fig. 1. Jig used for determination of shear modulus.

***Trademark of American Cyanamid Co.

finishes and, hence, better commercial laminates. The second is to eliminate the need for using large factors of safety for structural applications.

One approach that might be suggested in the development of better laminates is a study of the effect of fabricating variables (time, temperature, dimensions, pressure, and restraint) on the resin itself and on the forces acting at the laminate interface. Such a study, however, is hindered by the fact that work devoted to means for achieving reproductible fabrication has been scarce. Many methods of evaluating improvement in bonding do not take into consideration the uncertainties imposed by uncontrolled fabricating conditions.

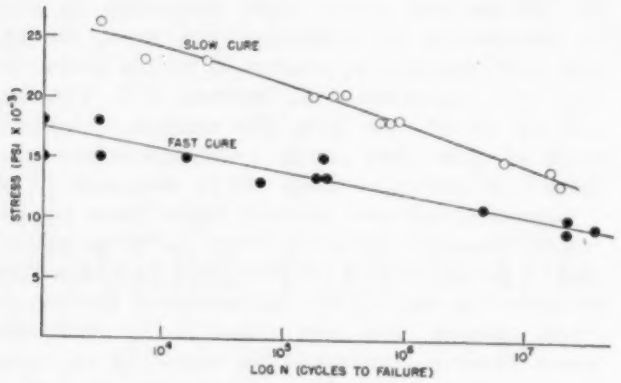

Fig. 2. S-N curves of laminates fabricated from 181-V12 glass cloth.

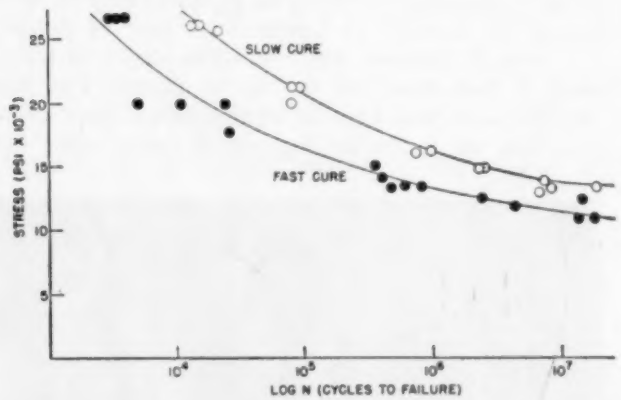

Fig. 3. S-N curves of laminates fabricated from 181-114 glass cloth.

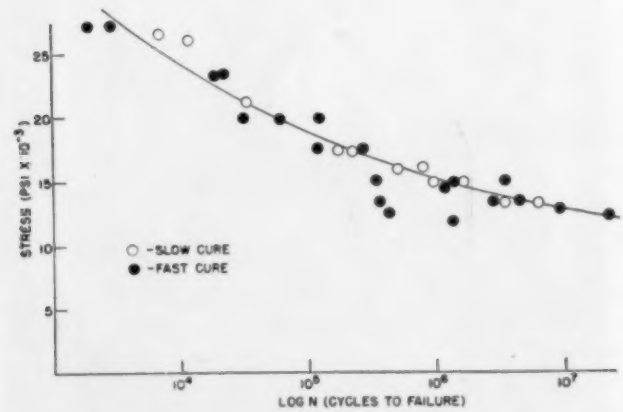

Fig. 4. S-N curves of laminates fabricated from 181-136 glass cloth.

Apparatus and Methods

A brief description of the apparatus and methods of measurement and the reasons for using them is desirable at this point.

Fatigue

A fatigue test in flexure incorporates many of the factors that contribute to the behavior of a laminate when subjected to a general pattern of dynamic stresses. When a sample is flexed, a complex stress pattern is set up in the laminate which includes shear, tensile and compressive forces. These forces are acting on the resin, the glass, and the bonds between the two. In contrast to stress in tension where the glass fibers carry most of the load, application of shear and flexural forces such as occurs in fatigue causes the resin to sustain a substantially higher level of stress.

The Model SG-2 Sonntag machine used for carrying out fatigue tests generates a repeated force acting alternately in opposite directions as a result of oscillation produced by rotation of an eccentrically supported weight. A constant force of up to 25 pounds can be exerted on the specimen at 1,250 cycles per minute. By proper choice of specimen dimensions, stresses as high as 90,000 psi. can be applied.

The specimens used were triangular cantilevers with the load applied at the vertex of the triangle. This geometry produces a uniform stress over the length of the sample. The triangular outline, as well as fillets at the vertex and base of the triangle were made by a procedure described by De Waard (4).

The fatigue limit of a sample is the highest stress which will not cause failure regardless of the number of times it is repeated. Steels and ferrous alloys as a class have fatigue limits, inasmuch as their S-N curves level off. Some of the laminates tested failed to show such a limit up to more than 107 cycles. Hence, for this paper, when one laminate is said to have better fatigue properties than another, it is meant that at the stresses studied, more cycles were required to fracture the specimen.

Shear Modulus

Shear modulus was determined by using a method based on measuring the deflections of a thin plate of the material subjected to twisting couples on its boundary (5, 6, 7). As shown in Figure 1, the jig has two supporting points, A and C, and two loading points, B and D, which are positioned at the corners of the test specimen. Rotatable ball bearings sealed in adjustable screws minimize undesirable tensile stresses resulting from friction when the specimen is being loaded.

The loading arm of the jig is connected to the load cell of an Instron Tensile Tester by a chain. The flexibility of this system allows correct positioning of the load points, and assures equal distribution of the load to the two corners of the specimen. The two supports (A and C) are fastened to the cross-head.

A dial gage mounted perpendicular to the cross-head, with its foot in the plane of the supporting members of the jig, provides for measuring the deflection produced by the application of the load. Deflection

measurements were made at the center of the specimen, where they are maximum.

The formula ideally assumes the load to be applied at the exact corners of the specimen. The specimens were designed with small extended tabs at the corners to approach ideality as closely as possible.

Damping

A knowledge of damping is of particular importance when the material is to be used in applications involving repeated stressing. This property largely measures the ability of the material to suppress vibration, and the extent to which heat is generated within the material when subjected to cyclical stress. Damping characteristics, since they are believed to be associated with the forces that hold solids together, may also be expected to reveal something of the structure of laminates.

The importance of damping as a design factor has been discussed in detail by Robertson and Yorgiadis (8), Föppl (9), Hague, Kimball, and many others. As Föppl pointed out, a material of high damping capacity and comparatively low fatigue strength may be superior in some applications to one of high fatigue strength and lower damping.

The test used for measuring internal damping in the laminates and resin castings employed very low stress (10). In it, a cantilever specimen is excited to vibration by a stylus whose frequency is increased continuously and automatically from slightly below to slightly above the natural frequency of the specimen, while the amplitude of vibration is simultaneously recorded. Analysis of this response curve provides the information necessary for computing damping and dynamic moduli.

Damping is defined as

$$\psi = \frac{f_2 - f_1}{f_o}$$

where f_o is the natural frequency of the specimen, and f_1 and f_2 are the frequencies where the amplitude equals the root mean square of the maximum. Modulus can be computed from the dimensions of the specimen and its natural frequency. Derivations regarding this method are described fully by Joos (11).

Flexural strength and modulus under both dry and wet conditions (two hours in boiling water) were measured according to ASTM Method D790-49T.

Microscopic Examination

Much useful information can be obtained from microscopic examination of glass cloth-reinforced laminates. Photomicrographs of the cross-sections were used to obtain information regarding the presence of flaws or extent of internal cracking as influenced by the type of finish and the curing cycle used.

Test Results

The S-N curves, Figures 2-4, indicate laminates S-V 12 and S-114 to be superior in fatigue strength to

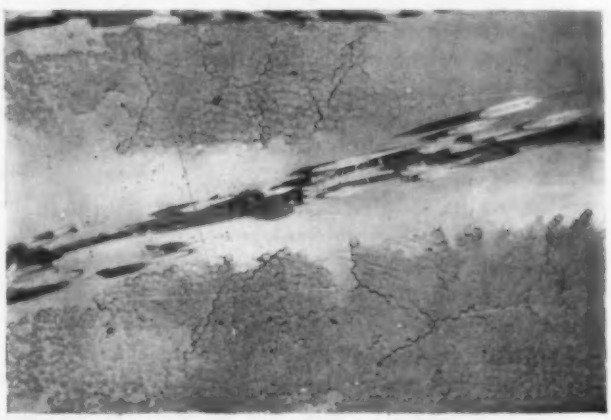

Fig. 5. Photomicrograph of cross-section of laminate fabricated of 181-V12 glass cloth. Fast cure.

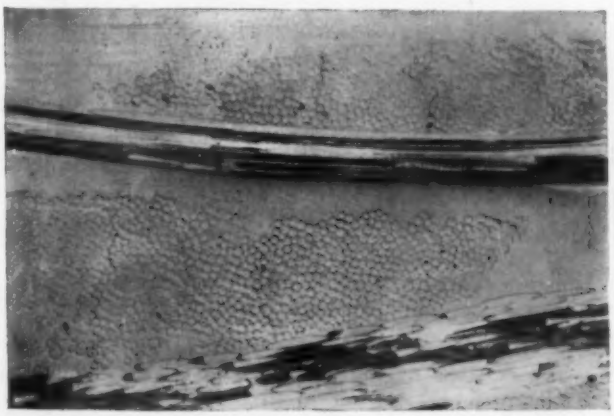

Fig. 6. Photomicrograph of cross-section of laminate fabricated of 181-136 glass cloth. Fast cure.

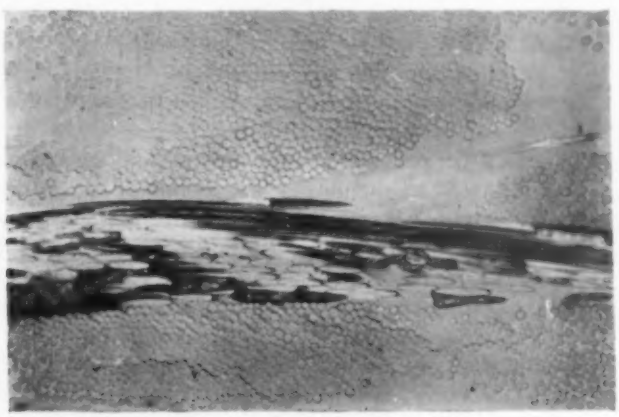

Fig. 7. Photomicrograph of cross-section of laminate fabricated of 181-V12 glass cloth. Slow cure.

Fig. 8. Photomicrograph of cross-section of laminate fabricated of 181-136 glass cloth. Slow cure.

F-V12 and F-114. However, it is seen that the rate of cure has no observable effect when the 136 vinyl silane finish is used. In the fast-curing cycle, F-136 has greater fatigue strength than F-114 or F-V12, in that order. The slow cure (S) reveals no difference in their fatigue properties.

Evidently, additional fatigue strength is imparted to laminates S-V12 and S-114 as a result of the slow cure. Table 1 also shows that other properties for the laminates receiving the slow cure are equal or superior to those listed for the fast cure. Properties of the S-V12 laminate are comparable to those of S-114 and S-136, except that flexural strength after a two-hour boil is decidedly lower. The photomicrographs of Figures 5 and 6 illustrate the more extensive internal cracking found in laminate F-V12 than with F-136. These internal cracks provide a passageway for water, promoting damage over a larger volume of the material.

The improvement of laminates made under slow cure, and the similarity of the S-V12 laminate properties to those of S-114 and S-136 is probably not a result of a change in the resin arising from the cure or catalyst system used. No significant difference is noted in Table 2 between the modulus or the specific gravity values of castings made under conditions simulating the curing cycles used for the laminates. The significance of the small increase in flexural strength is doubtful, and is not of sufficient magnitude to cause the increase noted for the laminates in Table 1. Although data are not available, it seems reasonable to assume that these changes are not attributable to the glass. A significant change in damping is present.

Possibly the differences in fatigue strength and the other mechanical properties studied is due mainly to difference in magnitude of the forces acting at the interface because of the cure method and the mechanical behavior of the finish. The bonds at the interface may be damaged to different extents in the fast and slow cures, depending on the finish, because of differences in rate of cure and consequent effect of unrelaxed stresses. These stresses are attributable to shrinkage of the resin in curing, and to differences in the coefficients of thermal expansion of the resin and glass. Volume shrinkage, based on specific gravity measurements, is about 11%

Differences in the coefficient of linear expansions of the resin and glass can be equally important in that stresses equivalent to a differential shrinkage of 1% or more would be produced. If this is so, it may mean that an important function of the finish is not only to act as an intermediate to bond the resin chemically to the glass, but also as a deformable layer capable of relaxing shear stresses at the interface, especially during rapid cure. This would strengthen the laminate by reducing "frozen-in" stresses, and by increasing the efficiency of the resin in transmitting the load to the glass fibers. We should like to try to interpret the experimental data in this light.

The physical properties listed for V12 in both cures are, with two exceptions, equal to those found for the other laminates. Its flexural strength (dry), shear moduli (G), flexural moduli, and damping characteristics are equal to or higher than those of 114 and 136. The photomicrograph in Figure 5 of a cross-section of F-V12 laminate suggests that the linkages remaining intact, despite the degrees of damage, are probably as strong and stiff as those of the other laminates subjected to the fast cure. A stiff, rigid linkage may not be the sole criterion for a good laminate, as evidenced by the poor fatigue performance and poor retention of strength after a two-hour boil.

A brittle linkage between resin and glass would explain the behavior, both good and bad, of V12 in both cures. Residual stresses, a result of the shrinkage and the rapid rate at which it occurs in the fast cure, cannot be relaxed since the bond is elastically rigid. This would account for the internal cracks noted in Figure 5, and would explain the low retention of strength after a two-hour boil. The severity of these internal stresses, since they are not relaxed, would then be sufficient, when superimposed upon the applied fatigue stress, to cause failure and, thus, the low fatigue limit noted for F-V12. Lack of continuity in this laminate may also lead to stress concentrations.

Laminates F-136 and F-114 are also subjected to the stresses caused by the relative motion of the glass and resin due to shrinkage. In these instances, however, a deformable layer in the form of a finish is available at the interface. The linkages in these laminates, although not as strong or as stiff as those assumed in V12, could be ductile and, hence, have the ability to relax and relieve the stresses. This may be the explanation for the lower moduli, equal flexural strengths, and improved fatigue strengths of F-114 and F-136. Moreover, there is less evidence of internal cracking in Figure 6, the photomicrograph of the cross-section of F-136. This, again, could substantiate the proposition that the finish is acting as a deformable layer capable of relaxing stresses.

Referring again to Table 1, we note that the properties of the laminates, regardless of the finish used, show a definite improvement when the slow cure is employed. In each instance, except for retention of flexural strength after boiling, the properties of S-V12 are equivalent to those listed for S-114 and S-136. The photomicrograph for S-V12 (see Figure 6) shows a definite improvement in continuity over that obtained in the fast cure. There still is evidence of internal cracking, so we might expect the deleterious action of the water. No obvious evidence of internal cracking is present in S-136, as shown in Figure 8.

In the slow cure, although the shrinkage is the same in magnitude, the rate at which it is occurring is much slower. This slower rate may allow the viscous components of the linkages, and perhaps also those of the resin, to be effective in preventing the build-up of internal stress in the laminate. This would result in the increase noted in the fatigue and flexural strengths, flexural modulus, shear modulus, and dynamic modulus, and the decrease in damping for the laminates cured slowly (see Table 1).

The decrease in the damping capacity of the castings because of the cure is approximately equal, percentage-wise, to that observed for the laminates. It has been inferred that the decrease in damping found in the slowly cured laminates (see Table 2) is an

Table 1. Properties of Parallel Laminates Fabricated from 181-V12, 181-136, and 181-114 Glas Cloth (Tested in Warp Direction)

Glass Cloth Type and Finish	Cure	Flexural Strength, Psi.			Shear Modulus, Psi. x 10^{-6}	Flexural Modulus Psi. x 10^{-6}				Fatigue Rating
		Dry	Wet*	Retention,%**		Static Dry	Static Wet	Dynamic	Damping	
181-V12	Fast	50,700	16,400	30	0.65	2.8	2.0	2.9	0.0092	3
181-V12	Slow	58,200	20,800	35	0.84	2.9	2.0	3.3	0.0056	1
181-136	Fast	48,600	37,600	80	0.61	2.5	2.0	2.8	0.0083	1
181-136	Slow	61,700	57,500	95	0.72	3.0	2.6	3.1	0.0051	1
181-114	Fast	52,100	26,100	50	0.55	2.6	2.2	2.8	0.0084	2
181-114	Slow	61,400	43,600	70	0.72	2.9	2.5	2.9	0.0059	1

*Two-hour immersion in boiling water prior to testing.
**$\frac{\text{Strength Wet}}{\text{Strength Dry}} \times 100$

Sp. Gravity
*1.228
**1.220

Table 2. Properties of Resin Castings Cured Under Conditions Simulating Those Used for Laminates.

Flexural Strength, Psi.	Flexural Modulus, psi. x 10^{-6}		Damping	Sp. Gravity
	Static	Dynamic		
14,000	0.48	0.61	0.0187	1.228
14,600	0.53	0.62	0.0129	1.220

indication of the continuity of their structure or the extent of internal cracking. In the castings, the differences are definitely significant and are results of a change in structure, the residual stresses present, or the manner in which the polymer chains are held together.

Damping is a sensitive measurement of minute changes in resin formulations. The fact that this property is so different while the others remain the same is not surprising. The need for more work on this phase of the problem is evident.

Summary and Conclusions

Some factors limiting the achievement of maximum strength have been studied. Constant stress, flexural fatigue data, flexural strength and modulus, damping, and dynamic modulus measurements were examined to learn the benefits to be derived from the use of various finishes and a fast and slow curing cycle. These data imply that an important function of the finish is not only to act as an intermediate to bond the resin chemically to the glass, but also as a deformable layer capable of relaxing shear stresses at the interface, especially during rapid cure.

Acknowledgements

I should like to thank members of the Physical Measurements, Microscopy, and Reinforced Plastics Groups in the Stamford Laboratories of American Cyanamid Co. for their aid and cooperation in the preparation of this paper. The permission of the directors of the Laboratories to publish this paper is appreciated.

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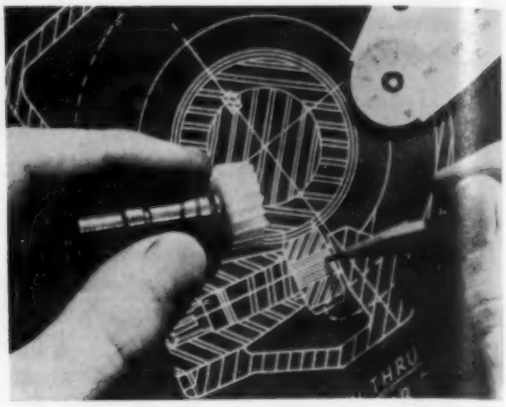


Machining of plastic parts obviates the need for expensive molds in short production runs.

Cryogenic Machining of Plastics

The increased use of plastics as materials of engineering requires that metalworking shops turn to the machining of plastics in order to maintain sales volume. Although most plastic parts can be molded to critical tolerances, the high cost of complex dies make molding infeasible for short production runs. Plastics machining requires little in the way of special tools; however, physical and mechanical characteristics of plastics should be understood thoroughly before any attempt is made to set up production.

In the machining of metals, both the tool and the work carry away the heat of friction as chips are sliced and torn away from the stock. Since plastics are poor conductors of heat, the tool must do the job alone. This leaves a considerable amount of heat concentrated in the area of cut. Heat increases the resilience of thermoplastics, causing them to be compressed by the tool and spring back after its removal.

Standard Automation Products, a division of General Industries of America, has adopted a Cryogenic or low-temperature method for the successful machining of plastic parts. This brings up a new set of problems, since low temperatures cause plastics to undergo reversible and irreversible changes. The former include such effects as thermal contraction, loss of moisture, increased modulus of elasticity, increased yield strengths, decreased ductility, and decreased resistance to impact. Irreversible effects include crystallization, dimensional changes due to change in state, and physical failure.

Care must be taken that the temperature is varied only through the range of reversible changes in the plastic being worked. Suitability of a plastic material for low temperature machining is governed by the following properties: linear or volume coefficient of thermal expansion, toughness, dimensional stability, and rigidity. Since water acts as a plasticizer for some plastics, humidity must be controlled as well.

Thermoplastics can be chilled to a predetermined level and held within $\pm 2°$ F., through the use of industrial refrigeration units. Feed-in boxes, insulated with a non-hygroscopic material such as Styrofoam, give added temperature control to the point of machining. For turning and boring operations, the feed should be continuous since any stoppage will mar the work. Coolants are not recommended with chilled material; however, a directed jet of cold air has been found helpful. Skived forming tools are used, and spindle speeds should be high to produce even cuts with the softer materials.

Speeds of 1,400 rpm. are recommended for screw machine work on thermoplastic rod stock. Single-point cutting tools should be V-shaped; with a 20-25° clearance, 30° side rake, and a 5/32-inch radius at the tip. Polystyrene clearance, however, can be as little as 10-15°, with a 2° negative top rake.

Tools are mounted at, or slightly below the centerline of the part. If the plastic has a tendency to force the tool downward, it can be offset by mounting the tool point a few thousandths above the centerline. HSS tools are used at speeds of 250-300 sfpm., carbide-tipped tools at 500 sfpm. Feeds should be about 0.12-inch per revolution for slow speeds, 0.005 ipr. for the faster cuts.

In drilling chilled plastics, holes should be started slowly. Through holes also should be finished slowly to prevent chipping at the break-through point. Since thermoplastic stresses are relieved by the heat of machining, these parts should be heat-treated to remove stresses before the actual operation.

Carbide tools are a must for graphite-, paper-, asbestos-, and glass-filled thermosets, which generally are unaffected by frictional heat. Surface speeds of 600-1,000 sfpm. are recommended for ureas and melamines, and the higher figure is suggested for phenolics. Lower speeds of 400-800 sfpm. are required for non-abrasive laminates; 100-150 sfpm., for the glass fabric-based combinations. The cutting tool should have greater clearance with laminates than with metals, in order to prevent the heel from dragging against the work and interfering with the succeeding cut. Tool rake should be slight and, in some cases, negative. —THE END

Vacuum Forming

A paradise for the experimenter

Edited by:
E. BOWMAN STRATTON, *President,*
The Auto-Vac Co.,
Bridgeport, Conn.

SOMETIMES I think we need less expert advice on the development of vacuum forming. Reports from the field would indicate that this flexible process is still in its pioneering stage; however, many successful applications were declared by the so-called "experts" to be impossible, unworthy of trial, and impractical. This type of negative thinking distinguishes these individuals from the true entrepreneur and experimenter.

Our collective hat is off to the many small custom formers who daily are trying new and "unacceptable" ideas in this field. Manufacturers of vacuum forming equipment are not far behind them in providing the tools for wider and greater applications of the process. Larger machines with greater platen size, greater drape, greater production capacity, etc., are lending practical expression to ideas considered unattainable only a couple of years ago.

To illustrate this, let us consider such an important new development as the forming of dashboard covers, arm rests, wall-to-wall stiffeners, and other auto-trim parts. Here, vacuum forming has been combined with foaming processes to produce an entirely new type of product.

One former is experimenting with basic triangular shapes which interlock when assembled to form tetrahedrons. These, in turn, may be assembled into the ultra-modern geodesic structures of the future.

Another former is undertaking a study program of products now molded as solids, and is succeeding in forming them into warped planes. He has formed small wheels, double-S shaped in cross section, from styrene and other heavy-duty, heavy-gage plastics.

Still another vacuum former is experimenting with a new sheet material which scarcely can be considered thermoplastic. Once having been formed, it hardens with new properties and softens only at much higher temperatures.

Finally, an independent former is experimenting with the production of large curtain-wall surfaces which, if successful, may bring vacuum forming into the construction materials industry.

Vacuum forming is indeed a paradise for the experimenter—the amateur who confounds the experts. These are the people who will supply the impetus to this new industry. Would that there were means for greater exchanges of ideas and technical information among them, however impractical sounding this might be.

—THE END

News of the Societies

AIC Officers Elected

The election of new officers for 1957 was announced at the annnual business meeting of the American Institute of Chemists, held May 23 in Akron, O. The roster includes: president, Henry B. Hass, Sugar Research Foundation; president-elect, Emil Ott, Food Machinery & Chemical Corp.; and councillors-at-large, Johan A. Bjorksten, Bjorksten Laboratories for Industry, Inc., Charles H. Fisher, Southern Utilization Research Branch, U. S. Department of Agriculture, and Karl M. Herstein, Herstein Laboratories.

New honorary members, announced at the meeting, include: Arnold O. Beckman, Beckman Industries, Inc.; Harold A. Levey, American Products Mfg. Co.; Bernard E. Schaar, Schaar & Co.; and W. E. Hanford, M. W. Kellog Co. Presentation of the honorary membership certificates will be made at a later meeting.

New SPE Section Formed

A new Section has been added to the Society of Plastics Engineers, Inc.—The Rocky Mountain Section. It embraces northern New Mexico, including Albuquerque; southern Wyoming; Colorado; western Nebraska, including Hastings; and Salt Lake City. Meetings will be held the third Thursday of the month.

New officers are: president, Oscar B. Yorker, Yorker & Sons, Inc.; vice president, Paul Barrick, University of Colorado; secretary, J. Ellis Chaney, Chaney Plastics Co.; and treasurer, Ray Millard, Denver Plastics.

ASME Elects Oscar Schier

The American Society of Mechanical Engineers has elected Oscar B. Schier, II, to succeed Clarence E. Davies as secretary and chief administrative officer of the 50,000 member organization. Mr. Davies has retired after 23 years of service.

Mr. Schier has been a member of the Society since 1932, and has been a member of the staff for 11 years. He was elected assistant secretary in 1953, and advanced to the post of deputy secretary last December. He was formerly associated with Consolidated Edison Co. of New York.

SPE Newark Section

Nearly 100 Members and guests attended the April 10 meeting of SPE's Newark Section, held at the Military Park Hotel in Newark, N. J. The entire program was devoted to "New Concepts in the Compression and Transfer Molding of Thermosetting Materials."

Speaker for the evening was Edward F. Boro, Durez Plastics division, Hooker Electrochemical Co. Although he expressed confidence in the continued growth of phenolic molding compounds, Mr. Boro indicated that future progression will be at a slower rate than for themoplastics. He emphasized that continued perusal of new applications is necessary, and approaches to new applications should be made intelligently.

Selection of the proper compound for any new product is most vital. In the general-purpose class of phenolics, there are 24 different compounds. Other classes, such as impact or dielectric phenolics, have as many or more different materials. There are one- and two-step materials. The one-step is ammonia free, but requires a post cure; and the two-stage materials are prone to cracking in the presence of moisture.

Basic principles of mold wear, volume electronic preheating, case hardening conditions, and insert gating for mold wear in transfer molding were discussed. Mr. Boro also showed slides on plasticity ranges, temperature relationships, pressure and flow-time requirements, effects of charge weight, closing time, curing times on total cycles, and the effect of preheating on mold temperature requirements.

May Meeting

The Section met on May 8, again at the Military Park Hotel, to hear talks on "Materials, Tooling, and Machines," by Monsanto's Bennett Nathanson, and "New Concepts in Chrome Plating for Plastic Tooling," by Arthur Logozzo, Nutmeg Chrome Co. Over 80 members and guests were in attendance.

Mr. Logozzo narrated a color film, covering the developments in this field. This showing was followed by considerable discussion as to the potentials of chrome plating.

Mr. Nathanson restricted his discussions to the styrenes, stating that the industry needs new materials and methods to meet the challenges of rigid packaging. The main problem in obtaining quality pieces has been consistent fill out of all cavities. Difficulties were caused by inadequacies of the machines, slow materials, and non-uniform plasticizing rates.

Quality containers at economic r would require direct improvement in terials for better flow and flexibility performance, heating of the cylinder more efficiency in Plasticizing, and m which would permit adequate flow of r without sacrifice in quality or product

To meet these requirements, runner molding, runnerless molding, flow styrene, and more efficient machi were developed. The essential feature hot-runner molding are temperature trol, reduction of heat transfer, and all ance of a safety factor. Fewer cavities required for runnerless molding, w offers many other advantages. The im styrene copolymers furnished the an to materials improvement.

New machines with faster inject speeds and plasticizing rates, gre horsepower requirements, and micro- ond accurate timing devices accelerate trend away from the utility-type mach The new units are very specific in nat

SPI Elects Midwest Officers

New chairman of the Midwest Chap Society of the Plastics Industry, Inc., W. D. McKay of Keolyn Plastics, He will serve throughout the fiscal y of June 1, 1957-May 31, 1958. New elected vice chairman is R. A. Becw Becwar Mfg. Corp.; and Donald E. G General Molded Products, Inc., has b reelected secretary-treasurer. W. D. Wo ruff, Celanese Corp. of America has b appointed chairman of the arrangeme committee, and will direct any spec events scheduled by the group during forthcoming year.

SPE Miami Valley Section

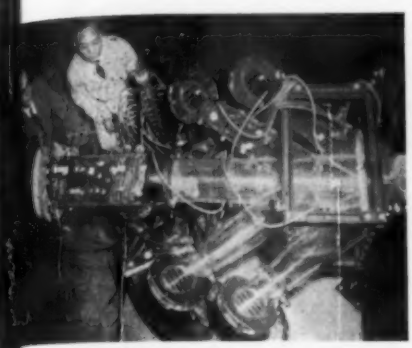
SPE's Miami Valley Section met on M 2, at the Golden Lamb Hotel, Lebanon. Speaker for the evening was Harry Dent, Jr., Durez Plastics division, Hoo Electrochemical Co., who spoke on "C ored Polyester Molding Compounds."

Mr. Dent reviewed the research a development which had gone into t project, and explained their physic chemical, and electrical properties. Amo the advantages claimed for the compoun are excellent dimensional stability, leng of flow in molding, and shelf life. Lar complicated parts reportedly can molded with a complete absence of fl lines.

SPE Western New England

SPE's Western New England Secti elected officers for the 1957-1958 "me ing year" at a recent meeting. They announced as follows: president, R mond Mazur; vice president, Richa Plichta; secretary, Wesley Larson; a treasurer, Edward Duda.

News of the Industry



Acrylic model of a water-pumping station.

Permits Turbulence Studies

Transparent, cast-acrylic models of a water-pumping station have enabled engineers at the University of Michigan to minimize water turbulence and reduce operating costs at a $6-million plant, soon to be erected by the City of Detroit. Confetti flown through the optically-clear tubing simulated the normal flow of water through a pumping station, thus enabling the engineering team to detect areas of excessive turbulence which, in normal operations, cause pumps to handle less than their designed load.

Cadillac Plastic & Chemical Co. supplied the acrylic tubing, and fabricated the model on a scale of 1:21. Over 46 design changes were made in the course of the investigation, which is expected to save more than $100,000 in projected operating and construction costs. Among the design features tested in the model are turning vanes, guide vanes, honeycomb baffles, false walls, partitions, bell mouths, floor humps, and concentric circles.

The model study was conducted by Professor Victor L. Streeter of the university's civil engineering department. He also serves as consultant to Ayres, Lewis, Norris, and May, an Ann Arbor, Michigan engineering firm which holds the design contract for the pumping station project. The station will be built in Detroit's Waterworks Park, on the main intake line from the Detroit River. It is scheduled to deliver a billion gallons daily, more than double the city's present water supply.

Morton-Withers Reveals Plans

Expansion and reorganization of its technical sales service facilities has been announced by Morton-Withers Chemical Co., Greensboro, N. C. A new laboratory has been constructed, and Robert E. Lally will serve as director of technical service.

A complete development and test service will be offered on Morflex plasticizers and polyesters, and work will be conducted on custom formulations and synthetic petroleum sulfonates. Other expansion plans call for the tripling polyester and plasticizer production, and for the introduction of several new polymeric products.

Elects Corporate Officers

General Industries Co., Elyria, O., has announced the results of its recent board election. Allan W. Fritzsche, president and general manager since 1943, was elected chairman of the board. Former vice-president, William E. Foster, was named president of the company.

All directors were reelected, and director H. E. Moon was elected first vice president. The firm's plastic division does custom molding for the automotive, appliance, and electronic industries. The injection molding plant is located in Marysville, O.

Spin-Welding of Thermoplastics

A technique for joining thermoplastic parts has been perfected by Du Pont's sales service laboratory. Called spin-welding, the technique utilizes the frictional heat generated by rotational rubbing of two surfaces to melt and join the desired parts.

Spin-welding is applicable to parts with circular joints, since these can be rotated against one another in a modified lathe, drill press, or the like. One part is held stationary in a special adapter while the other is rotated against it. The joint is permitted to heat until an adequate melt is obtained, after which time the pressure is increased and the adapter released to allow both parts to spin together. This automatically stops the rubbing action and allows the weld to form.

Adequate pressure is maintained until the melt has set. High speed creates more frictional heat and minimizes cycle time; however, too-high speeds create extreme vibration and eccentric surface contacts. Extremely low speeds, on the other hand, tend to grind or shear the parts. Proper speeds promote centrifugal forces which, in turn, tend to eliminate flash from gathering at the center of the weld. Experienced operators soon can judge the proper cycles, speeds, and pressures required for good welds.

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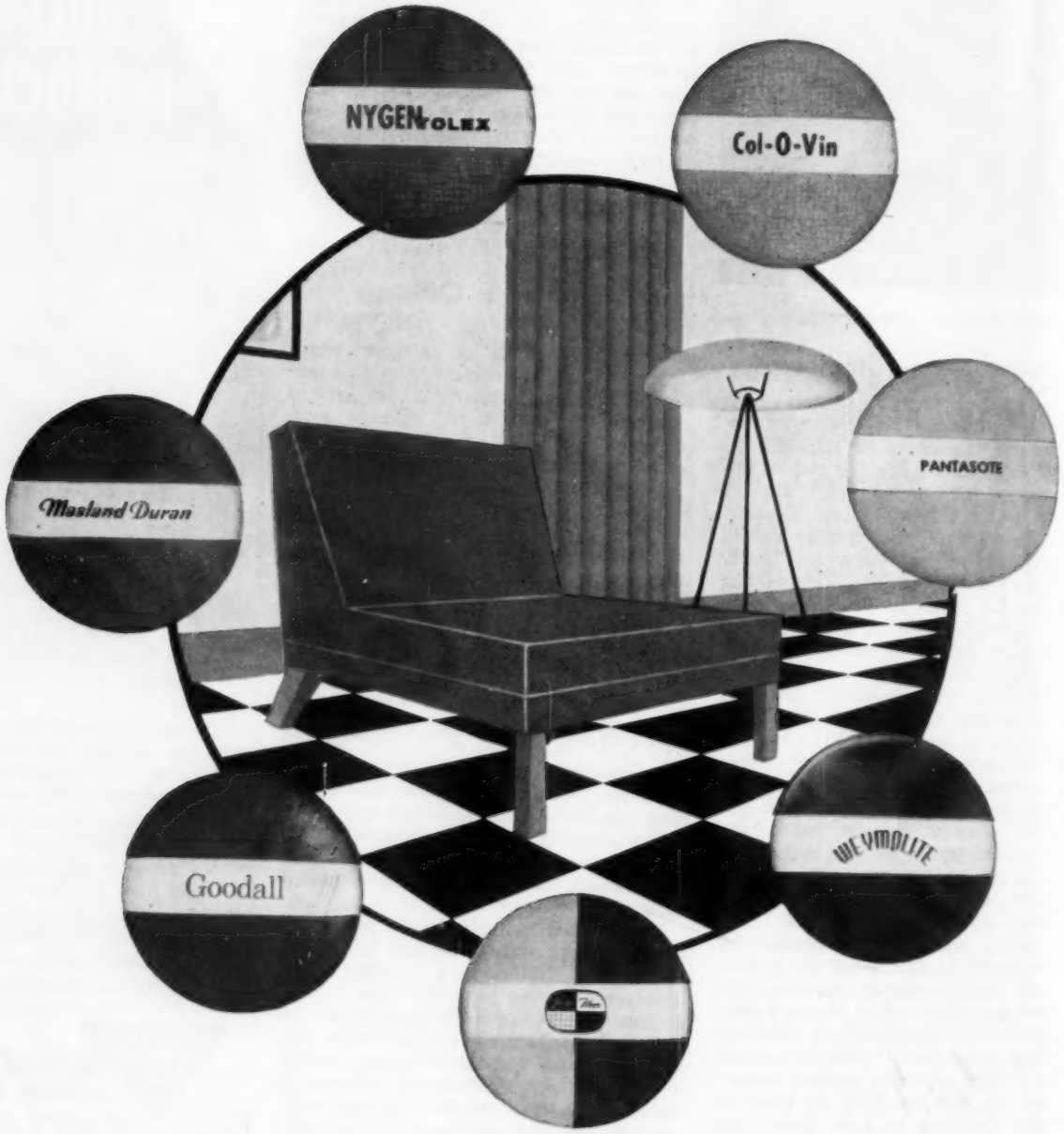

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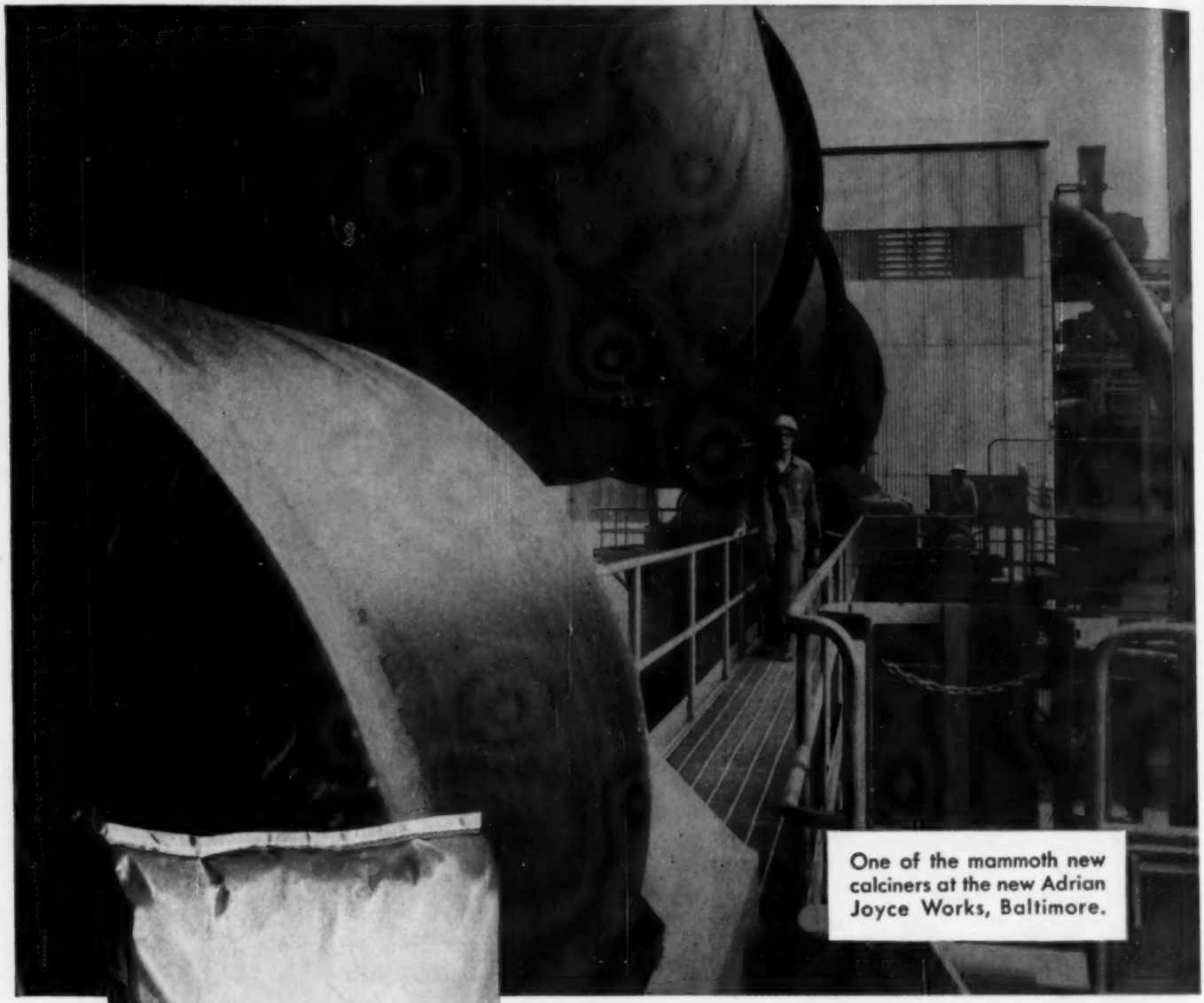

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Collette Marks Fifty Years

Marking its fiftieth year in business, Collette Mfg. Co., Amsterdam, N. Y., distributed 10,000 golden-anniversary miniature footballs to key accounts, distributors, and jobbers. Made from a Stanley Chemical plastisol formulation, they are exact replicas of the Ti-Nee toy football manufactured by the firm for domestic and foreign distribution.

Using a rotational molding method, Collette reports great success with the vinyl plastisols in color accuracy, ease of processing, and durability. The company produces more than a million footballs, basketballs, volleyballs, soccer balls, and floor punching bags annually, and is experimenting extensively with plastisols for the manufacture of these items.

Offers Larger Sheet Sizes

Laminated plastic sheets measuring 36 by 72 inches are now available from Synthane Corp., Oaks, Pa. The firm has installed a hydraulic press, designed and built by the Birdsboro Steel Foundry & Machine Co., which has two, 34-inch rams operating at pressures of 2,500 psi.

The press has a 10-opening platen with side plates keyed and bolted to the main cylinder and top platen. Its 20-opening elevator permits loading of every other opening during the pressing cycle. A complete load of plies or sheets is thus ready for insertion at the end of each press cycle. The new machine has enabled Synthane to increase its sheet pressing capacity by 40%.

Adopts Distinctive Trademark

A new and distinctive trademark for its corporate organization and chemical products has been adopted by Diamond Alkali Co. called the "Chemical Diamond," the new emblem suggest both the letter "d" for Diamond and a chemical retort, and encloses a vertical diamond. It replaces the conventional horizontal lozenge of diamond-shaped design which had been used for a number of years.

Hits Quarter-Century Mark

The average layman does not think of Eastman Kodak Co., as being one of the pioneers of the plastic industry, although the firm first marketed a plastic base for photographic films in 1889. The year 1957 marks a slightly different anniversary, however—25 years of Tenite plastics production. Through its divisions, Tennessee Eastman Co., and Texas Eastman Co., the parent firm has been producing these plastic raw materials since 1932.

As early as 1909, Eastman began experimental work with cellulose acetate as a fire-resistant replacement for cellulose nitrate. Commercial production of cellulose acetate as a molding powder began a quarter-century ago, and enjoyed great success due to the material's unlimited range of color possibilities. Eastman introduced Tenite butyrate in 1938, and commenced polyethylene production in 1954.

Eastman has undertaken a number of commemorative projects emphasizing the contributions of Tenite plastics to product development, processing technique, and research. These include a color movie entitled "Portrait in Plastics;" a color publication, "Tenite Plastic Views;" and a bronze, plastic medallion which shows one of the first injection molding machines produced in the United States.

Chemtrol To Double Capacity

One of the country's largest designers and manufacturers of corrosion-resistant plastic valves, Chemtrol Corp., has moved to larger quarters at 1417 W. El Segundo Blvd., Compton, Calif. The new, 10,000-square foot plant should enable the firm to turn out 100,000 units monthly, a 100% increase in production over previous capacity. The ball valves are available in PVC and Penton, Hercules Powder's chlorinated polyether resin.

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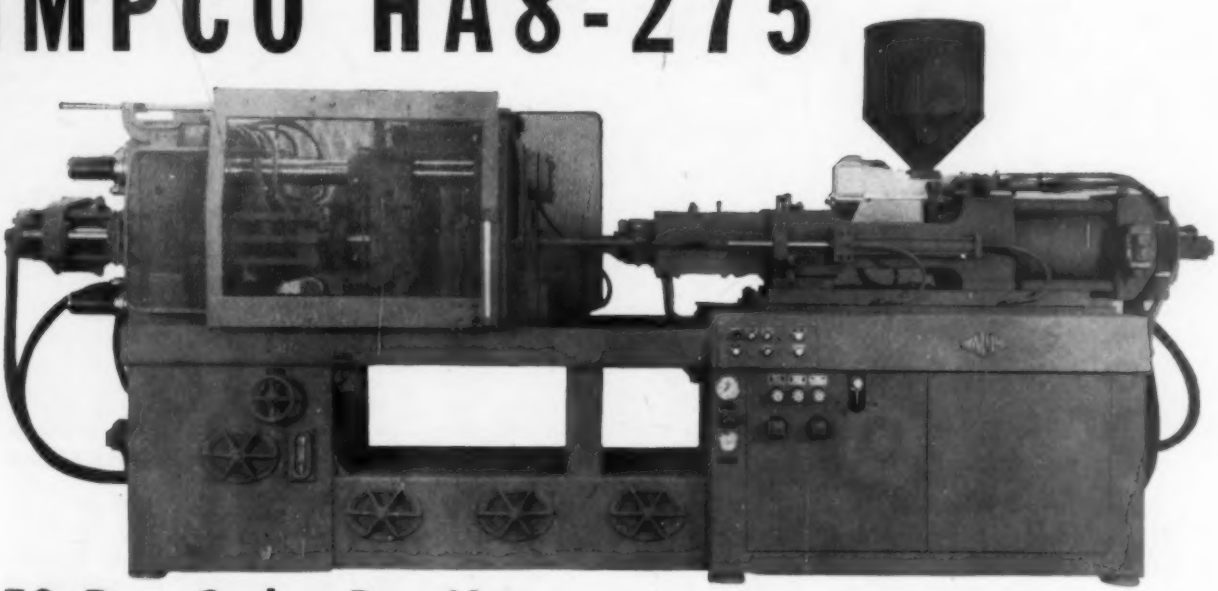

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Enter Plastics Pipe Field

One of the country's leading manufacturers of clay pipe and brick, Evans Pipe Co., Uhrichsville, O., has purchased a plant in nearby Carrollton for the manufacture of polyethylene pipe. A new division has been established, designated Evanite Plastic Co., which will offer two complete lines of the pipe in diameters of ½-6 inches. Type 1 has been approved by the National Sanitation Foundation for carrying potable water and foods, and Type 2 will be used for watery wastes and chemical service.

The Carrollton plant includes 20,000 square feet of working space, as well as the latest in extrusion equipment. Walter S. Prendergast will serve as general manager; John E. Gallagher, plant superintendent; and William R. Gallagher, technical superintendent and research engineer. Both lines will be manufactured in Schedule 40 standard-wall and 75-pound working pressure types.

Forms Plastics Marketing Firm

A new company, which will specialize in marketing and financial services to the plastics industry, has been organized as J. B. Durra & Co., with offices at 77 West Washington St., Chicago, Ill. Among the services offered are market research and development, product development, financing, and both acquisition and sales of plastics firms.

Company head is Joseph B. Durra, former advertising and sales-promotion manager of Ciba Co.'s plastics division. While services are aimed at small to medium-size companies, the Durra firm also offers its services to the development departments of large organizations.

Coupled with marketing facilities is an arrangement with a leading resin consultant to provide technical and product development service. Agreements have been reached with a number of investment and commercial banks to furnish financial assistance for clients. Aid in merger negotiations is offered.

Automotive Trends Predicted

New trends in the consumption of materials for passenger cars, especially fabrics, fibers, vinyls, and foam rubber, are covered in Marketing Report No. 152 recently released through the Agricultural Marketing Service of the Department of Agriculture. The report is based on a survey conducted by Stewart, Dougall & Associates, who conducted comprehensive interviews with fifty individuals in five automobile manufacturing companies: top management, chief engineers, chief stylists, and designers.

The amount of vinyl used rose from 5,001,465 pounds in 1950 to 45,424,351 pounds in 1955. Less vinyl, however, will be used for trimming cars of the future, with other synthetics replacing it as upholstery in the low- and medium-priced fields. It probably will remain as the seat-covering material in the lowest-priced models due to its favorable price. For sidewalls, increased use is indicated; and perforated, cotton-backed vinyls should see considerable use as headliners.

Asked what material they would prefer regardless of cost considerations, the auto executives expressed strong preference for nylon, either alone, blended with rayon, and either backed or un-backed by cotton. Nylon nearly doubled its usage during the last five years—going from 4,097,688 to 7,257,970 pounds.

Future use of preformed headings, door panels, and seat cushions was predicted. One company reported using a preformed, snap-in heading experimentally. Experiments with unsupported vinyl and copolymer door panels are being considered seriously. Polyurethanes and foam rubber are being used experimentally as model seats, crash panels, and both sound and thermal insulation.

To Expand Teflon Facilities

Plans for a major expansion of its facilities for producing Teflon at the Washington Works, Parkersburg, W. Va., have been announced by E. I. du Pont de Nemours & Co., Inc. Output of Teflons 1 and 5, materials used for compression molding and extrusion, will be increased 30% by mid-1958. Construction already underway will double production of Teflons 6 and 30 by late 1957.

Simultaneously, Du Pont allocated funds for the design of a plant to produce Teflon-X, an experimental perfluorocarbon resin. This material has a melt viscosity low enough to permit its extrusion by standard equipment, and is expected the over-all line of fluorocarbon resins.

Opens Cycolac Production Unit

A $10-million chemical plant for the production of Cycolac resins has been opened by the Marbon Chemical division of Borg-Warner Corp., near Parkersburg, W. Va. Called the Woodmar plant, it consists of a group of fireproof buildings, dispersed for maximum safety and efficient operation.

The facility is located on a 322-acre site, and has a 3,500-foot frontage on the Ohio River for receiving incoming raw-material shipments. It is served by five wells which supply 1,800,000 gallons of water per day, and is linked by some 57 miles of electric cable.

Completed in less than a year, the new plant was made necessary by the increased demands for Cycolac resins. The materials will continue to be produced at Marbon's two other plants in Gary, Ind.

In Brief . . .

Witco Chemical Co., New York, N.Y., has announced the formation of an international division which will be directed by Robert I. Wishnick, chairman of the Witco board. The new division will be responsible for the sale and manufacture of all company products outside the United States, as well as all foreign licensing arrangements entered into by the company.

Resistoflex Corp., Roseland, N.J., manufacturer of corrosion resistant hose and hose assemblies, has announced the formation of a southwest division at Dallas, Texas. Full-scale sales and assembly services now are available to that area.

Baldwin-Lima Hamilton Corp's Hamilton Division, Philadelphia, Pa., has appointed the A. V. Wiggins Co., Inc. distributor for its presses in the Syracuse, N. Y. area. The latter firm will distribute all types and sizes of Hamilton mechanical presses, including metal powder and plastics compacting types.

National Vulcanized Fibre Co., Wilmington, Del., has announced the addition of nylon to its line of basic engineering materials. The nylon is available as extruded rod, and as finished fabricated parts.

Emhart Mfg. Co., Hartford, Conn., has recently obtained all rights to the complete line of vacuum forming machinery formerly produced by Vacuum Forming Corp., Port Washington, N. Y. Identified by the trademarks VacForm and VacTrim, the equipment now will be manufactured by Emhart's Henry & Wright Div., Hartford, Conn.

B. F. Goodrich Industrial Products Co., Marietta, O., has announced the availability of a new Koroseal vinyl wall covering pattern. Made with an elastic back for upholstery use and in special construction for wall covering, the new pattern, called "Moss", is available in 13 colors.

Sillcocks-Miller Co., Maplewood, N.J., has announced the addition of facilities for the custom molding of DuPont's Mylar film in ½-mill thicknesses. Prior to this, the firm produced Mylar only in thicknesses from 1 to 7½ mills.

Monsanto Chemical Co., Everett, Mass., has expanded its facilities for the production of phthalic anhydride. The expansion, designed to better serve the eastern market for the resin intermediate, has increased the plant's capacity by 60%.

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5213

News from Abroad

French Plastic Industry

The French plastics industry has developed rapidly in the last five years, with production soaring from 35,150 tons in 1952 to 128,030 tons in 1956. Consumption showed an equally spectacular rise, 57,830 tons in 1953 to 159,339 tons last year. If the industry continues to progress at the same rate, consumption of 500,000 tons can be anticipated by 1960.

The May 1957 issue of Industrie des Plastiques Modernes lists the following tables:

Production—Metric Tons

	1956	1955	1954	1953	1952
Cellulosics	5,630	4,800	5,000	4,000	3,650
PVC	40,600	32,220	24,000	16,000	12,600
Polyvinyl acetate	8,000	5,000	3,000		
Polymethacrylics	1,250	985	830	540	550
Polyamides	1,550	3,240	800	—	—
Polystyrenes	17,120	11,600	8,000	3,260	—
Polyethylene	5,600	3,990	1,800		—
Phenoplastics	15,700	14,500	12,480	6,200	6,750
Aminoplastics	13,180	10,550	9,400	4,660	4,200
Soluble Resins	16,100	7,770	7,800	7,700	7,400
Silicones (in commercial forms)	380	180	150		
Polyesters	2,420	910	70		
Casein	500	500			
Totals	128,030	96,245	73,330	42,720	35,150

Consumption—Metric Tons

	1956	1955	1954	1953
Cellulosics	6,578	5,700	5,230	4,850
PVC	38,044	30,702	21,820	
Polyvinyl acetate, alcohols acetate and polyvinylidene chloride	10,590	5,846	3,940	17,400
Polyacrylics	2,346	1,896	1,460	1,250
Polyamides	1,515	1,418	800	1,200
Polystyrenes	20,005	12,339	12,090	8,950
Polyethylene	17,600	6,780	5,500	1,300
Phenoplasts	20,474	17,200	13,820	7,700
Aminoplastics	21,150	14,500	12,130	6,800
Soluble Resins	17,700	10,800	8,400	8,100
Silicones	250	180	300	250
Polyesters	2,500	1,050	180	30
Epoxy Resins	534	100	40	—
Polyfluoroethenes	25	20	—	—
Polyurethanes	28	40	—	—
Totals	159,339	108,575	85,710	57,830

It is estimated that with the equipment already installed, 1957 output of PVC could reach 55,000 tons. Demands for polyethylene have grown considerably, and last year's domestic production covered only one-third of requirements. A factory for high pressure polyethylene is under construction at Port Jerome, Normandy, and, by 1958, at least one of the several installations planned for the production of low pressure polyethylene should be in operation. France expects to produce 40,000-45,000 tons of the low pressure material annually by 1961.

The French output of polystyrene in 1956 included 3,650 tons of the high-impact type, at least a third of which was absorbed by the refrigeration industry. Over-all production of styrene is increasing and should reach 30,000 tons a year before long. One concern will be making over 10,000 tons during 1957, and it is learned, another large firm has begun the manufacture of styrene-acrylonitrile copolymers. Interest in glass-reinforced polyester resins is growing and production during 1957 may reach 250 tons a month. It is noteworthy that almost 11½% of last year's total output was used by various firms and individuals for experimenting with new applications.

Among new developments is the manufacture of raw materials for polymethacrylics. The Societe Ugilor first developed organic, synthetic derivatives of acety and hydrocyanic acid from raw mate in 1954. A factory was recently compl at St. Avold, Moselle, and acrylates methacrylates are scheduled to come by late 1957 or early 1958. When in production, the factory is expected supply all French needs as well as a plus for export.

Polyfluoroethylene has not yet b made in France, but a group of industr ists recently formed the Societe des Res Fluorees, which may begin operations 1958. Production of epoxy resins scheduled for about the same time.

Terephthalic Acid Processing

A new method of processing terephth acid has been developed at the Insti for Technical Chemistry, Martin Lut University, Halle-Wittenberg, East G many, in collaboration with the resea department of V.E.B. Hydrierwerk Ze A semi-industrial installation capable producing 700-800 kilograms monthly reportedly in operation.

The method is described as follo toluol is carboxylated with carbamyl chl ide, the p-toluic acid amide underg alkaline saponification, and is oxidized terephthalic acid in alkaline solution. Si only the p-compound is obtained by t process, no separation of by-product necessary.

Russians Tour Great Britain

Returning the visit paid Soviet Rus last year by a delegation of British plas manufacturers, a group of plastics te nicians from the USSR arrived in Lond on April 30. The British Plastics Fede tion entertained them at a reception London, and arranged a full program factory and laboratory visits.

Plastics in Venezuela

Although Venezuela must import plastics raw materials, an up-surge the production of moldings, extrusions, films has occurred over the past five ye In addition, the government's policy furthering industrial development to duce economic dependence on petrole has resulted in the lifting of part of import duties on plastics materials pro essed within the country. A contin rise in plastics production is expected, at a slower rate than that experien lately.

Operating mostly on a small scale, firms employ 250 people to proc plastics in various parts of the coun Fifteen companies utilize injection mo ing equipment, producing tablewa combs, coathangers, soap dishes, jewe boxes, toys, wall tile, etc. Six firms extruders of tubing, pipe and pipe co nections, and electrical conduit mater

...company is engaged exclusively in manufacture of polyethylene film, from ...ch it makes food and garment bags. ...other firm produces partition and ceiling ...els from fibrous glass-reinforced poly...rs. Several companies also manufacture ...orative articles from imported plastic ...and sheets.

Expansion efforts within the industry are ...ected in the construction of a large ...rication facility in Valencia. With ...ipment for calendering asbestos-poly...yl chloride floor tile, the factory was ...ected to commence operation in late ...6. An increase in polyethylene film ...put also is forecast.

While molded and extruded products ...e attained a high level of sales, the ...t industry remains the largest con...er of plastics materials, with the ply...od and textile industries consuming ...er volumes. In processing, competition ...keen, and management is aware of the ...d for low raw-material cost, favorable ...dit terms, and education in modern ...rication techniques.

The United States is still the largest ...plied of plastics raw materials and proc...ing equipment, although a consider...e amount of business has been diverted ... European sources because of lower ...es and more liberal credit terms. For ...tance, polystyrene is delivered c.i.f. ...Guaira at prices ranging from one to ...o cents per pound less than that asked ... American producers. German ma...inery and German and Italian molds are ...ered at roughly one-half the price of ...ilar American equipment, and with ...edit terms up to 180 days.

Despite the price differential, however, ...ny important end users prefer Amer...n products because of uniformity of ...ality and prompt delivery as compared ...h a two month waiting period from ...st European sources. American ma...inery also is favored by some because of ... better operation and greater availabil... of replacement parts.

Other than the fact that export and re...port of plastics materials and finished ...oducts are subject to prior license by ...e Ministry of Development, there are ... government decrees or regulations ...ecifically affecting production, labor con...tions, consumption, or domestic and ...reign trade. The labor law, however, ...es require that of the personnel em...oyed by any enterprise, at lease 75% ...ust be Venezuelans.

...lastics in Peru

The Peruvian plastics-processing industry ...nsists of 10 molders using low-capacity ...jection and compression molding ma...hines. Five of these firms account for ...% of the consumption of polystyrene, ...ea-formaldehyde, phenol-formaldehyde, ...olyethylene, and small quantities of PVC ...olding materials. A few, small, continu...us-extrusion machines have been installed ...y one of the leading molders, and two ...ire and cable manufacturers. Total capital investment is estimated at about $500,000, and products include tableware, kitchen items, knobs and handles, bottle caps, buttons, bags, combs, toys, electrical sockets, switches and plugs.

The country has a need for technical information on new applications, as well as newly-developed molding techniques. Reportedly, there exists a promising field for expansion and improvement in fabrication methods, especially in the manufacture of plates, sheets, and fabrics which are being imported in larger quantities every year. No unfavorable legislation exists with respect to production, consumption, labor conditions, and domestic or foreign trade. High tariff protection has been granted to new producers of end products.

The use of plastics raw materials has been increasing steadily during the past few years. Paint manufacturers are making greater use of synthetic resins in an effort to improve their coating formulations. Alkyd resins used in paints during 1955 amounted to 220,000 pounds and were expected to reach 270,000 pounds in 1956. Consumption of phenolics in the same period is estimated at 180,000 and 215,000 pounds, respectively. Maleic resins moved from 90,000 pounds in 1955 to 115,000 pounds in 1956. An even greater consumption of resins is expected during the next two years.

Acrylic sheets and plates are used chiefly by furniture and advertising material manufacturers whose combined consumption increased from 250,000 pounds in 1955 to 350,000 pounds in 1956. A few leading tanneries and shoemakers are beginning to use acrylic emulsions for treating leather, with consumption amounting to 50,000 pounds in 1956.

The production of 75-rpm. phonograph records required 100,000 pounds of ethyl cellulose in 1956, and is expected to require 120,000 pounds annually in near future.

Total PVC consumption amounted to 245,000 pounds, 95,000 pounds of which were used in the manufacture of coated wire and cable. Polyethylene reached a total consumption of 145,000 pounds. During the 1957-1958 period, these materials are expected to be used in quantities to 500,000 and 220,000 pounds, respectively,

Plastics in Chile

Fabrication of plastics in Chile has been increasing steadily for several years, with total annual consumption of raw materials being estimated at 1,500 metric tons. With the exception of one paint factory, which produces 240 tons of alkyd resins yearly and plans to produce modified phenolic resins, the industry depends entirely upon imported raw materials.

Eight of the 45 firms engaged in processing account for 80% of all plastics materials used in the industry. In 1955, their consumption amounted to 734 tons of PVC, 462 tons of polystyrene, 91 tons of phenolic resins, 39 tons of melamine, 36 tons of urea resins, and small amounts of plastic bars and sheets. Most of these materials were obtained from Western European sources, since exchange shortages and restrictions on imports from dollar areas have seriously limited the United States' share of sales in this market.

In 1956, however, a system of free imports on certain goods was introduced as a part of the government's economic rectification program. The new import and exchange policy has enabled fabricators to import as much raw materials and machinery as they wish to expand their operations. As a result, greater sales opportunities are anticipated for American exporters. U. S. manufacturers are generally regarded as the best source of supply because of product quality, good delivery schedules, little price differences between various materials, and adequate technical assistance.

Six of the major fabricating firms have a total plant investment of $4.5-million, and employ a total of 811 workers. Injection molding, extrusion, laminating, and calendering are the principal methods used to produce such items as vinyl film, supported leather goods, rigid sheets, vinyl-covered paper, household appliances, toys, radio cabinets, combs, buttons, automobile accessories, coated wire, garden hose, and containers.

There is no foreign investment in Chile's plastics fabricating industry, nor are there any United States or foreign-branch factories. Fabricators are genrally optimistic, and both production and sales are expected to increase during the next few years. Trade sources estimate that materials consumption will increase 10-15% above the average for 1955-56. During this period, 1,064,164 kilograms of powdered plastics materials valued at $743,808 were imported, About 98,315 kilograms valued at $80,353 were supplied by U. S. manufacturers.

German Plastics Meeting

The highly successful, Seventh German Plastics Meeting held at Bad Pyrmont on April 10-11, 1957, drew a total of 1,596 scientists and technologists from all parts of Germany, most other European countries, and the United States. Both the Soviet Union and Czechoslovakia were represented.

Dr. W. Mauss, president of the German Plastics Federation, presided over the meeting, which included presentation of the following papers: "Petrochemistry in the Plastics Industry," Prof. K. Winnacker, chairman of the board of Farbwerke Hoechst A. G.; "Nuclear Energy and Its Economic and General Significance," Prof. N. Gerlach, University of Munich; "Possibilities of High Energy Radiation of Plastics," Prof. M. M. Magat, director of research, National Center of Scientific Research, Paris; "Tools for the Extrusion Machine and the Method for Extruding Films," Dr. E. C. Bernhardt, E. I. du Pont de Nemours & Co.; and "New American Experiences in Stabilizing PVC," Dr. E. Parker, Advance Solvents & Chemical Co.

Names in the News

R. F. Pierce

R. F. Pierce has been promoted to the newly-created position of operations manager for the plastics division of Visking Co., a subsidiary of Union Carbide Corp., New York, N. Y. He joined Visking in 1943 and, in 1946, was named chief engineer for the plastics division.

Sydney G. Spivack has been named manager of molding operations for Victory Mfg. Corp., Chicago, Ill. **Arthur E. Backus** has been appointed sales manager for industrial products.

John B. Rauen has been named to the board of directors of Loven Chemical of California, Newhall Cal. He fills the vacancy resulting from the resignation of **Harry C. Millerburg.**

Richard H. Hall has been named manager of the Pacific division, Mycalex Corp. of America, Clinton, N. J. Headquartered in Los Angeles, Cal., he will be in charge of sales in the western states for the corporation and its affiliated companies.

Herman Muehlstein, president of H. Muehlstein & Co., Inc., New York, N. Y. has been made an honorary Doctor of Humane Letters by the University of Akron, Akron, O. The degree was awarded in recognition of his "notable contributions to the welfare of his fellow man."

Harriman H. Dash, former research director for Foam King, Inc., New York, N. Y. has been appointed technical director for the firm. **Philip C. Daidone** succeeds him to the research director's post.

William H. Shields, a veteran of 32 years with Emery Industries, Inc., has retired from his position as assistant research director. **Joseph P. Clancy** has been appointed eastern district sales manager of the organic chemical sales department. He succeeds **J. W. Ritz,** recently named assistant sales manager, and will be located in Philadelphia, Pa. Other changes in the organic chemical sales force include: **Joseph E. Quinty**, to Chicago, Ill.; **William C. Sowers**, to New York, N. Y.; and **Arthur R. McDermott**, to New England.

H. W. DuVal has been named sales manager of the chemical division, Reichhold Chemicals, Inc., White Plains, N. Y. He will be in charge of the division's domestic sales activities.

John M. Vanselow, former Philadelphia field representative for the L. O. F. Glass Fibers Co., Toledo, O., has been reassigned to the southeastern region where he will be headquartered in Jacksonville, Fla.

John J. Keville has been appointed eastern regional sales manager for the polymer chemicals division of W. R. Grace & Co., New York, N. Y. From the company's offices at Clifton, N. J., he will supervise sales personnel activities in the New England, middle Atlantic, and southern states.

Joseph Monahan, of the Joseph Monahan Co., Grand Rapids, Mich will represent the Automatic Molding Machine Co., Los Angeles, Cal., in the western half of Michigan.

Cryovac Co., Cambridge, Mass., has announced the appointment of three divisional sales promotion managers. **William Harrison,** operating out of the company's Denver, Col. office, will be the western division sales promotion manager; **William Squire** will be sales promotion manager for the southern division, and will be headquartered in Simpsonville, S. C.; and **Donald K. Beyer,** eastern division sales promotion manager, will operate out of the company's office in Lockport, N. Y.

R. P. Bowditch

R. P. Bowditch has been appointed assistant general product manager of Bakelite Co., New York, N. Y. He will be located at the company's production and development center, Bound Brook, N. J. Appointments of technical service representatives to the following district offices of the surface coatings division are as follows: **John T. Ingram, Jr.,** Cleveland, O.; **Robert D. Swain,** Washington, D. C.; **L. D. Mains,** Los Angeles, Cal.; **J. A. Nelson, Jr.,** Chicago, Ill.; and **George O. Young,** Boston, Mass.

F. J. Pyle has been elected vice president of the plastics division, Spencer Chemical Co., Kansas City, Mo. In his new capacity he will be responsible for all plastics products, including polyethylene and nylon, and will direct production, quality control, product improvement, sales, distribution, and technical service activities. With the firm since 1942, Mr. Pyle has had various works management positions, and most previously served as works manager of the Orange, Tex., plant.

John C. Louer, formerly associated with the Elmer E. Mills Co., has joined the staff of Artag Plastics Corp., Chicago, Ill., as production control manager.

Two additions to its expanding sales force have been named by Standard Tool Co., Leominster, Mass.: **J. E. Neuman,** as mid-west representative, based in Chicago; and **Milo Dellmann,** as West Coast representative with headquarters in South Gate, Calif. Mr. Neuman will service an area including Illinois, Indiana, Iowa, Minnesota, and Wisconsin, and will continue to handle the allied line of General Industries Co. Mr. Dellmann's activities will be centered in California, Oregon, and Washington. Both men have first-hand experience in molding and tool-making.

Paul E. Willard, Ohio-Apex research director of the organic chemicals division, Food Machinery and Chemical Corp., New York, N. Y., has been selected as a representative to the plastics division of the International Organization for Standardization meeting in Buergenstock, Switzerland, July 7-13. The purpose of the conclave is to establish international standards on test methods, and to decide on specifications and definitions for a wide variety of plastic materials.

New Materials

Write item numbers on Readers' Service Card to obtain more information.

Vinyl Plastisol Stabilizer

The original viscosity of vinyl plastisols reportedly can be maintained over extended periods of time with Camros VS-1, a special-purpose stabilizer develped by Camros Chemical Co. Requiring only 3-5 parts per hundred parts of resin, the material provides greater flexibility in the choice of plasticizes.

A water-white liquid, Camros VS-1 has been used to improve "tear-dropping" of dipping plastisols. It is non-toxic; and has no effect on light and light stability. Packaging is in steel drums weighing 30, 75, and 350 pounds net.

Readers' Service Item M-1

Low-Viscosity Vinyl Resins

An unmodified PVC resin exhibiting the processing properties of vinyl copolymers while retaining the physical properties of straight PVC has been developed by the chemical division of Goodyear Tire & Rubber Co. Designated Pliovic S50, the material has an inherent viscosity of 0.68 and can be processed at temperatures of 250-300° F.

Particle size averages 40 microns, a feature which allows it to blend readily with other resins or compounding ingredients. Excellent flow characteristics adapt it to both injection molding and extrusion. Since it can be processed at temperatures 50 degrees lower than those required of most vinyls, minimum quantities of stabilizer are needed. Shorter operating cycles also are possible.

Very little plasticizer is used in compounding the resin, and certain rigid products have been produced successfully without adding any plasticizer. The material has been found highly satisfactory for the production of vinyl-asbestos flooring, sheeting, and high fidelity phonograph records. It also can be used as a base polymer in nitrile-vinyl combinations.

A fine, white powder, Pliovic S50 is available in 50-pound multi-walled bags. A specific gravity of 1.4 and a bulk density of 44 pounds per cubic foot are reported.

Readers' Service Item M-2

Hardener for Epoxy Resins

A hardener for epoxy resins used in potting electrical components and other casting applications has been introduced by Smooth-On Mfg. Co. Called Sonite 21, the catalyst is an acid anhydride in white, powdered form.

For castings, the resin should be heated to 120° C., before adding the catalyst. Optimum mixing proportions are reported as 46 parts by weight of resin to 54 parts hardener. Recommended mold release agents are Dow Corning 7 Compound, D. C. 20 silicone resin dispersion, and G. E.'s Dri Film.

After stirring the resin and hardener for 5-10 minutes, the castings should be cured overnight at 150° C.; longer for large parts. At 120° C., gelation should occur within an hour. At this point castings can be removed from the mold for post cure.

Using equal parts of Sonite 21 with Bakelite ERL 2774 epoxy resin, a casting cured 24 hours at 140° C., showed the

VANSTAY Z

zinc bearing chelator for PVC resins imparts outstanding clarity, stability and resistance to sulfur staining when used as recommended with other VANSTAYS in many vinyl products.

Plastisols, Organosols, Extruded Goods

Use 1.5 VANSTAY R with .5 VANSTAY Z for maximum resistance to process heat and good service life.

Film, Sheeting, Molded Products

Use 1–1.5 VANSTAY HT with .5–1.5 VANSTAY Z to obtain the required protection.

When Roll plating is a problem:

Use 1.5 VANSTAY N with 1.5 VANSTAY Z as the stabilizing system.

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following properties:

Heat distortion temperature, °C	168
Tensile strength, psi	12,000
Flexural strength, psi	17,000
Compressive strength, psi	20,500
Hardness, Barcol	46-50
Burning rate, in./min	0.15
Weight loss, 7 days at 200° C., %	0.7
Specific gravity	1.4

Readers' Service Item M-3

Heat Stabilizer for Vinyls

A heat stabilizer for rigid and plasticized PVC has been developed by Ferro Chemical Corp. Called Ferro 1827X, the light cream-colored compound is a cadmium-barium fatty acid soap containing an organic inhibitor. In form, a free-flowing powder, the material has an average bulk density of about 4.2 pounds per gallon.

Ferro 1827X is said to impart an unusually high degree of clarity to vinyl compounds, a feature which is retained throughout processing. Its compatibility prevents exudation on long-term exposure to strong sunlight, even at moderate concentration levels. Lubrication properties are relatively low.

The stabilization effect of Ferro 1827X is further enhanced by the presence of epoxy plasticizers, or other epoxy additives such as Ferro 900 in plasticized formulations and Ferro 909 in rigids. Ferro 903 can be added to bring out the color in processing.

Readers' Service Item M-4

Clear Primer for Plastisols

A clear primer for vinyl plastisols called Stanley 69X-1406 has been introduced by Stanley Chemical Co. Baked or air-dried, the primer is said to provide excellent adhesion of plastisol to metal. The material finds application wherever a colored primer would be objectionable.

The primer should be thinned with Stanley 79R-192 until it has a viscosity of 17 seconds in a No. 2 Zahn Cup, for both dipping and spray coating. The prime coat should be baked for 5-10 minutes at 350-375° F., since any residual solvent would affect adhesion adversely.

Readers' Service Item M-5

Two Polyethylene Resins

Two polyethylene formulations have been placed on the market by E. I. du Pont de Nemours & Co., Inc.: Alathon 5F, a black, film and paper-coating resin which will resist outdoor weathering; and Alathon 31, a resin intended primarily for sheet extrusion and thermoforming.

Alathon 5F is supplied as ⅛-inch opaque cubes, which can be extruded under the conditions normally employed for making flat or blown film. Since the "drawability" of molten polyethylene is reduced by the addition of solids—in this case, carbon black; best results are assured only when extruding films of two-mils thickness or greater. Under suitable conditions, however, 0.7-mil films have been produced.

Properties for Alathon 5F are reported as follows:

Melt index, gms./min.	20
Density, gm./cc.	0.921
Tensile strength, psi.	1,750
Yield point, psi.	1,700
Elongation, %	400
Stiffness, psi.	21,000
Carbon content, %	2.5

Alathon 31 is supplied as white, translucent, ⅛-inch cubes. Its low melt index is said to cut down on sagging during the heating step prior to thermoforming. Its greater stiffness can be exploited through the forming of thinner-walled sections. The material can be extruded or calendered and, in sheet form, can be formed with or without the use of a plug assist.

Properties of Alathon 31 are listed as follows:

Melt index, gms./min.	6
Density, gm./cc.	0.93
Stiffness, psi.	40,000-45,000
Yield strength, psi.	2,100
Elongation, %	400
Softening point, Vicat, °F	227
Stress crack resistance, hrs.	100
Hardness, Shore D.	55
Water absorption, %	0.01

Readers' Service Item M-6

Spray-On Rust Preventive

A rust-preventive aerosol spray developed specifically to prevent corrosion on plastic molding dies has been introduced by Perc E. Harms Co. Called Slide No-Rust, the material consists of silicones and polar compounds which undergo an actual molecular exchange with the metal.

The spray is applied easily to recessed surfaces of the mold, and is dissipated by the first or second molding operation. Being self-cleaning, it obviates the need for cleaning the molds at the end of a day's production. Slide No-Rust can be used also with stamping dies, stripper plates, bolster plates, jigs and fixtures, rubber mold dies, die casting dies, precision instruments, and machine tool storage. It is supplied in 15-ounce cans, and in one-, five-, and 55-gallon lots.

Readers' Service Item M-7

Polyester Resin Thickener

A thixotropic agent which inhibits crawling, sagging, draining, and pigment settling in polyester resins has been developed by Baker Castor Oil Co. Designated Thixcin E, the additive features ease of "stir-in;" maximum results being attained at temperatures of 90-110° F.

Thixcin E is a finely-divided white powder with a melting point of 84-88° C., and a density of 8.24 pounds per solid gallon. Acid value is three, maximum, and the particles all pass through a 200-mesh screen. It is available in 50-pound bags.

Addition of as little as 0.2-0.4% produces a significant increase in viscosity. Reportedly 5-10 times as effective as existing products, it compensates for the reduction in viscosity brought about by increasing the styrene content of polyester resins. Chemically, the material is a non-toxic, non-discoloring derivative of castor oil.

Readers' Service Item M-8

Ink Series for Vinyl Resins

Tarnish-resistant bronze-gold and copper inks for gravure and valley-printing of vinyls are now available from Claremont Pigment Dispersion Corp. Known as the VC-4200 Series, the inks are said to have a four-fold increased resistance to the tarnishing effects of light exposure. They also exhibit superior brilliance and resistance to greening.

The new inks do not show any color change until after 80 hours of fadeometer testing, and only slightly up to 200 hours. They resist greening up 72 hours at 170° F., and at two psi. Ink removed by the Taber Abraser after 30 cycles is equal to that removed from a conventional bronze-gold print after 10 cycles, a three-fold increase in abrasion resistance. Completely crock-resistant, the inks are available in three shades: pale gold, rich gold, and copper.

Readers' Service Item M-9

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New Equipment

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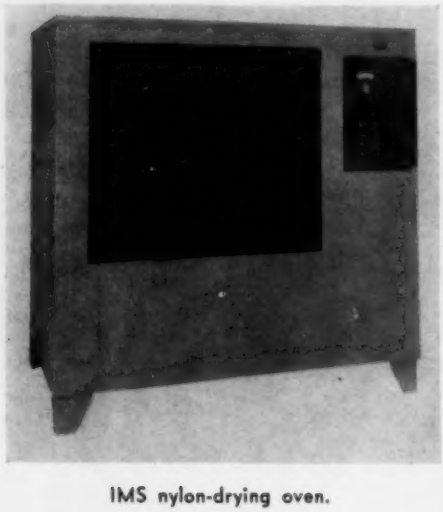


IMS nylon-drying oven.

Mechanical Dehumidifying Oven

A mechanically-operated dehumidifying oven for nylon and other thermo-plastic powders is available from Injection Molders Supply Co. Reportedly five times as efficient as desiccant-type dehydrators, it passes seven times more dry air over the powder than desiccant units can deliver. The new oven operates continuously, and is unaffected by chemical fumes which deteriorate and saturate the other-type units.

The IMS unit features a built-in dehumidifier, separate heating chamber, variable speed fan, and double the usual amount of heat. Its 12 drawers with removable innerliners measure 15 inches wide, 30 inches deep, by two inches high. Other dimensions include an over-all height of 64 inches, a depth of 36 inches, and a width of 63 inches. Shipping weight is 1,400 pounds.

Temperature range is 50-350° F., by Partlow control; however, the oven is capable of continuous duty up to 500° F. The 10-kw. Inconel-sheathed heating elements are completely sealed and isolated from the drying space. The ½-hp. fan motor operates at 1,750 revolutions per minute, and the ⅛-hp. motor for the dehumidifier allows a capacity of 25 pounds of water over a 24-hour period.

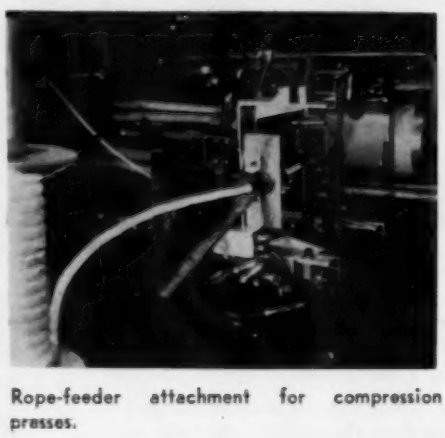
Readers' Service Item E-1

Press Rope-Feed Attachment

A rope-feeding attachment for compression presses, which permits the automatic molding of glass fiber-reinforced polyester resins, has been introduced by F. J. Stokes Corp. Developed specially for use with the Stokes model 741 press, it can be added to presses already in service or adapted to the Model 800 press.

The glass-reinforced polyesters, currently being supplied in extruded "rope" form, are drawn into a chopper where a guillotine blade slices off a piece of the desired length. This piece is dropped through one of the tubes into the proper mold cavity. The Stokes attachment can feed up to 24 cavities, located over the whole area of the platen, in virtually any arrangement pattern. Different molds can be used merely by changing the pattern of the lower feed plate, and altering the tube connections which lead from the upper feed plate to the lower.

Each tube feeds a single cavity in the mold. As the feeder indexes, two opposed jaws grip the plastic rope and draw it forward into the chopper. The attachment can be adjusted to take various diameters of rope and to cut pieces of various lengths, as required by the size of the part being molded. Over-all height,



Rope-feeder attachment for compression presses.

mounted on the press, is 94 inches. The width of the feeder is 29 inches; depth is 36 inches; and the weight is approximately 600 pounds. Both the feeder and cutting blade are air cylinder-actuated, and the electrical connections are 110 or 220 volts.

While polyester resins are somewhat more expensive than phenolics, they can be molded at less pressure, and the cure time is often faster. Electrical properties and impact strength are better; therefore, the lowered operating costs made possible by this automatic attachment may open new markets for these resins.

Readers' Service Item E-2

PHI's 300-ton hydraulic press.

Vertical Hydraulic Press

A 300-ton, double-acting hydraulic press is offered by Pasadena Hydraulics, Inc. The unit has three pressure gages covering ranges from 0-20,000, 0-120,000 and 1,000-600,000 pounds. Any pressure in the latter range can be maintained indefinitely with ±5% accuracy.

The press cylinder is 16 inches in diameter; rod diameter is 14 inches. The 300-ton thrust is followed by a 70-ton return. The ram is operated by a Hi-Lo pressure pumping system, which checks the ram speed before the point of close. Maximum distance between platens is 20 inches, as is the stroke. Deviation across the entire platen surface under uniform load does not exceed ±0.0015-inch.

Press height is 90 inches, and the distance between the uprights measures 23 inches. The 440-volt, three-phase motorized hydraulic system is controlled by magnetic brake and double shaft extensions. Three pressure switches operate the press at 0-10, 1½-40, and 20-300 tons. If the material flow does not exceed one inch per minute, accuracy is within ±½-ton.

The two, 18½- by 18½-inch, steam-heated platens permit loadings of 5,000 psi., and two pyrometers permit convenient observation of their temperature in both Fahrenheit and Centigrade. Rate of close for the press is 23 inches per minute, with a variable, low-speed closing of 0-23 inches per minute for any selected opening. Floor space required is 24 by 20 inches, and the gross shipping weight is 10,000 pounds.

Readers' Service Item E-3

Mechanical Vacuum Pump Line

The Series 4700 mechanical-booster, high-vacuum pumps is presently available from NRC Equipment Corp. Available in six sizes from 1,000-12,000 cubic feet-per-minute capacities, the pumps operate at top capacity throughout the broad pressure range of 5-2,200 microns. Applications range from vacuum-heat treating and melting to freeze drying.

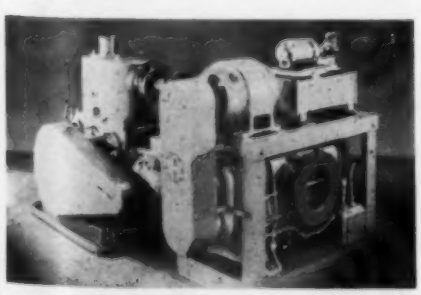
Operation is completely automatic from atmospheric pressure to blank-off. The pumps are said to provide peak performance at pressures below those at which ordinary mechanical pumps operate efficiently, and above those at which oil-vapor booster pumps lose their speed. No oil is used, either as a pumping medium or as a sealant, thus assuring an absolutely clean vacuum.

The pump is a multi-stage unit complete with backing pump, motors, bases, belt-guards, controls, and automatic protective devices. Two impellers, turning in opposite directions at high speed, compress the gas and move it to the discharge port where it is compressed further and discharged to atmosphere by the backing pump.

Impellers and housing are machined precisely and positioned so that a very small clearance is maintained. Timing gears ensure proper synchronization of the impellers, plus vibration-free operation. Pressure at the discharge end of the blower is low enough so that the small clearance offers high impedance to leaks from the counter-flow. Elimination of friction and absence of the retarding effect of oil sealers allow the rotors to turn at high speed.

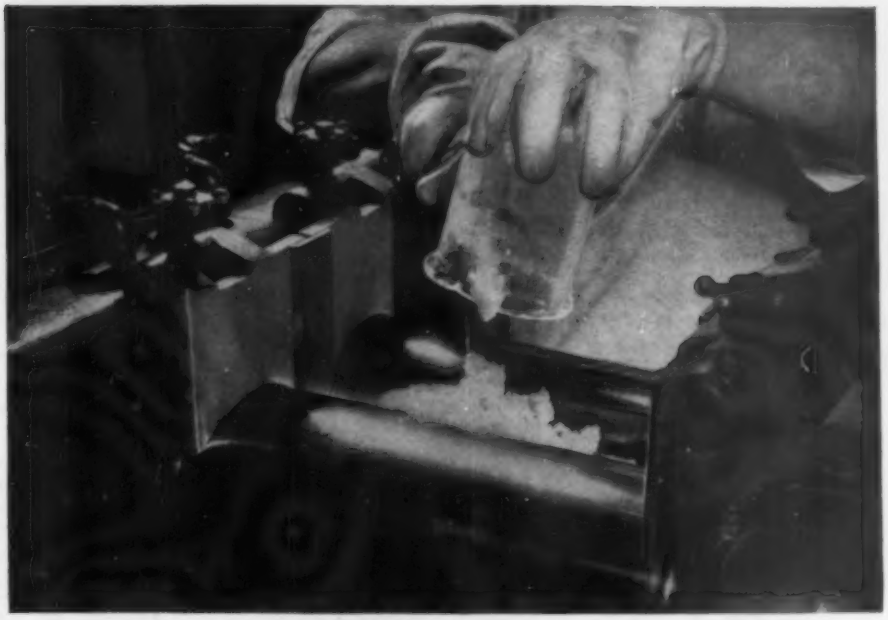
The backing pump is an NRC rotary gas-ballast pump, which operates at high efficiency even when handling water and other condensable vapors. Both backing pump and motor are mounted on their own base, thus allowing the introduction between stages of such auxiliary equipment as filters, condensers, and isolation valves.

In operation, the backer pumps through the blower until the system pressure is reduced to 15mm. A pressure switch automatically energizes the blower. A thermal cut-out protects the blower from overheating, which might occur from prolonged operation at pressures above one millimeter.



NRC mechanical-booster high-vacuum pump features completely automatic operation from atmospheric pressure to blank-off.

Readers' Service Item E-4



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Tests show that this efficient polymeric will plasticize PVC resins in 45 to 50 seconds. No secondary plasticizers are needed to produce plastics which are permanent, non-migratory, and have excellent low-temperature properties. Harflex® 300 is the first easy processing, polymeric plasticizer to become available for vinyl resins.

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New Products

Write item numbers on Readers' Service Card to obtain more information.

Scotchpak one-mil polyester film.

Low-Caliper Polyester Film

A one-mil, heat-sealable polyester film designed for light packaging jobs where moisture, oil, or odor retention is required has been introduced by Minnesota Mining & Mfg. Co. designated Scotchpak No. 10A3, the film has a tensile strength of 10,000 psi., and a burst strength of 32 psi. Elongation is 200% at break.

Other properties include a water-vapor permeability of one gram per 100 square inches in 24 hours, and an air permeability of 5.2 grams under the same conditions of time and area. Properties are retained through a temperature range from —70° F. to 230° F.

Suggested applications for the film include the packaging of oily foods, treated fabrics, and dried fruits; as well as the protection of maps and documents. It can be laminated to paper without heat damage to the fibers. The film is available in widths up to 19 inches and in roll lengths of 1,500 yards.

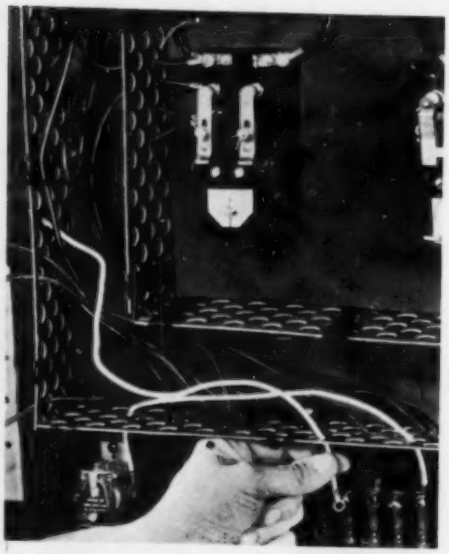
Readers' Service Item P-1

Control-Panel Wiring Ducts

A convenient method of locating and holding wires between components on control panels has been developed by Glastic Corp. Called Glastic Channel-Duct, the components consist of three fibrous glass-reinforced panels, the side members of which are punched with ½-inch diameter holes. These side strips are available two- and three-inches high, and the cover-strip width can be one, 1¼, 1½, 1¾, two, 2½, or three inches, as desired.

Lowered fabrication and assembly costs are reported with the ducting. Wires are laid and strung through the holes to the nearest connection points before the cover strip is snapped on. Mounting clips are available, and the number required per linear foot averages about four. The ducting is easy to shear and mount, and does not require mitered corners.

Glastic Channel-Duct offers full, Class B electrical insulation with UL-recognized flame retardance to 105° C. Used to replace hand-formed, solid-wire layouts, it obviates the need for expensive harnesses and simplifies maintenance. Other reported features include a dielectric strength of 5,000 volts minimum, high impact strength, dimensional stability, and superior arc resistance.



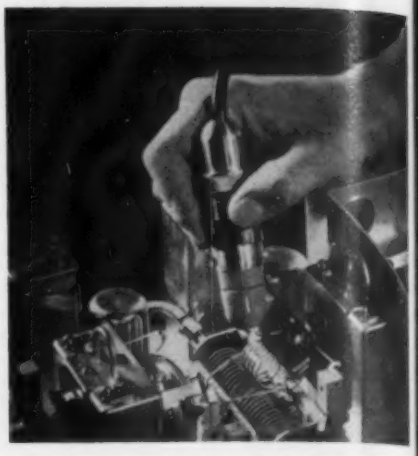
Reinforced plastic raceways for channel wiring.

Readers' Service Item P-2

Irradiated Polyethylene Tips

Irradiated polyethylene is being used to replace polystyrene in the high-frequency, vacuum-tube voltmeter probe tips produced by Hewlett-Packard Co. Not only do the tips withstand cracking at low temperatures which exposed the imbedded electronic components, but the irradiated polyethylene is cheaper than the polystyrene material.

Hewlett-Packard fabricates the tips of conventional polyethylene, and sends them to Applied Radiation Corp., for treatment by ARCO's 8-million volt linear electron accelerator. Tests indicate that the high-temperature resistance of the tips is increased to about 250° F., with little offect upon the resistance to low-temperature cracking.



Voltmeter probe-tip is irradiated polyethylene.

The tips are placed on a turntable which rotates beneath the electron scanning assembly. Electrons travel down the center waveguide at just under the velocity of light (186,000 miles per second), and emerge through a metal window in the scanning horn. Two magnets, placed astride the scanning horn, displace the electron beam back and forth across the moving samples.

Readers' Service Item P-3

Fluorocarbon Spaghetti Tubing

Three grades of Teflon "spaghetti" tubing, plus a sodium-treated tubing for potting operations, have been introduced by Fluorocarbon Products, Inc., division of United States Gasket Co. The tubing possesses outstanding dielectric characteristics, particularly low dielectric constant and loss factors, which remain constant over a measurable frequency range. In addition, the tubing will not carbonize under arcing and will not DC-plate.

Thin-wall tubing is available in wire gages 30-0, with corresponding nominal

Spools of Teflon tubing.

inside diameter of 0.012-0.33 inch. Sodium-treated tubing can be had in the same wire gages.

Standard-wall tubing sizes range from wire gage 24 with nominal I.D. of 0.022-inch to a gage of 30 with an I.D. of 0.33-inch. Standard-wall, sodium-treated tubing is available in wire gages of 0.24.

Heavy-wall tubing is obtainable in gages 24 through five, with nominal I.D.'s of 0.022-0.19 inch. Sodium-treated gages are 5-24.

Service temperature range of the tubing is —110° F. to 500° F., within which range it is non-gassy and will not deteriorate on the shelf. Teflon tubing is unaffected by humidity, corrosive atmosphere, fungus, and normal soldering conditions. It is available in a wide range of colors.

Readers' Service Item P-4

Durafoam slices easily with a pocket knife.

Prefoamed Epoxy Resin Blocks

Blocks of epoxy resin foam measuring up to 12 cubic feet have been placed on the market by Pilot Plants, Inc., under the tradename Durafoam. Based on an Epon resin formulation supplied by Shell Chemical Corp., the rigid blocks are made by simultaneous foaming and curing under carefully controlled conditions.

Since Durafoam is thermoset, it is unaffected by solvents and has a temperature resistance typical of cured epoxies. Readily machinable by ordinary woodworking tools, its freedom from grain affords an excellent surface for the application of finish coats. Four densities are available: 5, 10, 15, and 20 cubic feet.

Dimensional stability is reported to be exceptionally good, and pieces fashioned from it are free from warp on exposure to conditions of high heat and humidity. Core structure is essentially unicellular, therefore the material lends itself to flotation applications.

Readers' Service Item P-5

Teflon-lined hose assembly and flange.

Teflon-Lined Hose Assembly

Development of a fluorocarbon-lined, flanged hose assembly has been announced by Resistoflex Corp. Designed to prevent liquids or gases from contacting the metal parts of conveyor fittings, the unit is known as the Fluoroflex-T Flanged Hose Assembly. Fluoroflex-T is the firm's designation for a compound of Teflon, Du Pont's tetrafluoroethylene resin.

The hose assemblies have been field-tested for about a year, and have proven inert to hot hydrochloric acid, hydrofluoric acid mixtures, sulfuric acid, nitric acid, and steam injector lines. Other installations involve C.P. acids, pharmaceutical applications, and essential oils, where prevention of contamination is most important.

The assembly carries the plastic hose liner through the fitting and across the face of the flange. Specifically designated Type R5760, it is available in a wide range of sizes; the hose having an inside diameter of ⅝-1¾ inches. The flanged, coupling section is provided in modified ASA 150# forged steel, with flanges ranging from ½-in to 2 inches. All sizes can be had in 10-foot assemblies, or smaller, and still longer assemblies should be available in the near future.

A modification of this assembly is the Fluoroflex-T Double Flanged Hose Assembly, Type R5750, which incorporates a replaceable, secondary flange. This added part is jacketed with Fluoroflex-T compound, and is connected to the primary flange through stud connections. It is recommended where a relatively large number of connects and disconnects are expected, and gasket or sealing damage is restricted to the replaceable part.

Installation is basically the same as for any flanged item. Particular care should be taken in evening-up the bolts, and the recommended torque value for bolting is 150 inch-pounds.

Readers' Service Item P-6

No Asthma in a GLOBEMASTER!

When a Douglas C-124 Globemaster coughs too hard—when the engines backfire, as all engines do—the impact on the carburetor air intake duct is terrific. When these ducts are made of laminated fiberglass plastic, something must be added to keep them from delaminating from that impact, for pieces coming loose will indeed cause asthma, once the plane's movement brings a rush of air through the duct.

Materials and Process Engineers of Douglas Aircraft Company, Long Beach Division, working with Stoner Rubber Company, developed a liner of Silicone Modified Rubber. When this unique, tough rubber was bonded in place, no amount of backfire reduced the utility of the duct. The Globemaster could still breathe freely.

Your investigation of Silicone Modified Rubber, particularly when used in conjunction with plastic ducting, may solve some of your vexing problems.

In addition to increasing impact resistance, .020" wall phenolic ducting lined with .015 SMR shows zero leakage at continuous 50 p.s.i. This can be done in a one-stage manufacturing operation, with simultaneous cure and bonding of rubber and plastic.

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New Literature

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"For Products Waiting To Be Made." Stanley Chemical Co. 4 pages. The bulletin describes several successful applications of the firm's vinyl plastisols. Information is included on vinyl inks, wash primers, epoxy adhesives, and both potting and core-drier compounds.

Readers' Service Item L-1

"Heli-Coil Screw-Lock Inserts." Heli-Coil Corp. 8 pages. The brochure contains Screw-Lock selection tables with thread sizes, insert numbers and sizes, and complete information on drilling, tapping, gaging, and installation. Line drawings and photographs illustrating proper installation of the inserts in both blind and through-holes are included, as well as basic engineering design data, military specifications, classes of fit, and assembly proportions.

Readers' Service Item L-2

"Engineered Knives." Taylor-Stiles & Co. 3 pages. The company's fly and bed knives are described, along with the methods for manufacturing them.

Readers' Service Item L-3

"Gas and Water Vapour Permeability of Polyvinyl Chloride and Rubbers." Information Sheet G. 104. British Geon, Ltd. 6 pages. The effects of temperature, plasticizers, fillers, pressure and film thickness, molecular structure of polymers, and others, on the process of gas permeation through a polymeric film are discussed. The permeabilities of different types of nitrile rubbers and PVC for temperatures up to 50° C., are tabulated.

Readers' Service Item L-4

"Tufline Plug Valves." Bulletin S-1 Continental Mfg. Co. 2 pages. The leaflet describes Teflon-sleeved stainless-steel plug valves. A cut-away view illustrates the internal construction, and dimensions for several sizes are tabulated.

Readers' Service Item L-5

"Sonite No. 41—Hardener for Epoxy Resins." Technical Bulletin 13. Smooth-On Mfg. Co. 2 pages. The bulletin covers in detail the physical properties, handling, and mixing of the hardener, in addition to methods of curing, both large and small castings. Flexural, tensile, and edgewise compressive strengths, as well as moduli of glass cloth laminates at various temperatures are given.

Readers' Service Item L-6

"Vinyl Plasticizers: Trade Names, Composition, and Suppliers." Information Sheet G. 102. British Geon, Ltd. 16 pages. Nearly 500 plasticizers are catalogued alphabetically by tradename.

Readers' Service Item L-7

"Alathon for Modern Packaging." E. I. du Pont de Nemours & Co. 6 pages. The properties of Alathon polyethylene resins are described briefly and packaging applications are illustrated. A table lists the basic characteristics of the different types, together with recommended applications.

Readers' Service Item L-8

"Proved by Performance." Bakelite Co. 7 pages. Performance characteristics of polyethylene flexible pipe are given in addition to safe working-pressure specifications of standard wall pipe as approved by SPI's Thermoplastic Pipe Division.

Readers' Service Item L-9

"The Latest Lesters." Bulletin 202. Lester-Phoenix, Inc. 4 pages. This illustrated bulletin describes features of the company's injection molding mechines, and tabulates the operating characteristics of the several models.

Readers' Service Item L-10

"Plastics Catalog and Price List." Cadillac Plastic and Chemical Co. 14 pages. The catalog contains a complete price list of materials for fiber glass reinforced plastics including fabrics and fibers, polyester and epoxy resins and catalysts, and other necessary supplies. Available sizes, grades, and prices are shown under each material, along with thumbnail descriptions of properties and recommended applications. Property tables of polyester resins and fiber glass cloths are included.

Readers' Service Item L-11

"Process Control." Tracerlab, Inc. 36 pages. A technical handbook on industrial radiation gaging. The components of absorption and backscatter beta-ray gages and accessory items are described, in addition to applications of automated processes. An illustrated section shows some existing industrial uses of the equipment.

Readers' Service Item L-12

"The Epoxylite Story." Epoxylite Corp. 24 pages. The use of epoxy resins for the protection of all forms of large electrical apparatus is discussed. Epoxylite materials are described, and graphs and case histories are used to illustrate the advantages of this material as an insulator.

Readers' Service Item L-13

"A Key to a Fourth Dimension." Amston Plastic Engineering Co. 3 pages. The pamphlet explains the values of plastic working models as sales or training aids, and outlines the company's facilities for development-planning research.

Readers' Service Item L-14

"Hazard Finder." Crouse Hinds Co. 8 pages. The illustrated folder contains a check list of 13 industrial hazards such as uncontrolled flammable gases, vapors, dusts, liquids, or other combustible materials. Included is an evaluation of a plant's hazard potential, based upon findings of the National Fire Protection Association.

Readers' Service Item L-15

"Dur-X Plastic Pipe." Franklin Plastics, Inc. 16 pages. The complete line of Dur-X plastic pipe, tubing, and fittings is described. Complete data, specifications, and physical properties of three grades of polyethylene pipe are included, along with suggested applications and methods of installation.

Readers' Service Item L-16

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Book Reviews

"Chemical Engineering Reports." Fourth Edition. Kenneth A. Kobe. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. Paper, 8½ by 11 inches, 183 pages. Price, $3.00.

The sub-title of this book is "How to Search the Literature and Prepare a Report." As implied, the book's purpose is to assist the student in familiarizing himself with chemical literature, in learning to use it, and in presenting its facts to his superior in a suitable engineering report.

The section on chemical literature is very complete. It could be termed a complete bibliography of chemical reference books, periodicals, and other source material. Chemical economics literature is treated in the same fashion, and several pages are devoted to the proper sequence of steps in instituting a literature search.

Engineering reports are covered with respect to type and form. This includes both the letter report and the business letter, the text report, formal engineering reports, and the laboratory report. Still another section is given to the actual writing; including mechanical preparation, literature citations, and revision. An appendix lists accepted abbreviations, standard letter symbols, and engineering standards.

"Fibres, Plastics, and Rubbers." W. J. Roff. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y. Cloth, 5½ by 8¾ inches, 416 pages. Price, $10.00.

Intended as a handbook of common polymers, the book is divided into two sections covering data on individual polymers and data on specific properties. Tables are used rather than chapters.

Polymers are classified as carbohydrate-condensation types (cellulosics), amino acid-condensation types (silk & wool), synthetic linear condensation polymers (polyamides & polyesters), linear addition polymers (styrenes, vinyls, & rubbers), cross-linking polymers (ureas, melamines, phenolics, & some polyesters), and organosilicon polymers.

Properties and related information are classified as to structure, chemistry, general physical properties, thermal properties, electrical properties, mechanical properties, and general stability. Many additional references are cited.

"Handbook of Solvents—Volume 1: Pure Hydrocarbons." Ibert Mellan. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Cloth, 6¼ by 9¼ inches, 254 pages. Price, $6.50.

First in a series of volumes on the composition and properties of industrial solvents, this particular work is devoted to pure hydrocarbons of all types: aliphatics, aromatics, and terpenes. Commercial and propietary names are used in lieu of chemical nomenclature; the hydrocarbon solvents are classified in accordance with their distillation range; and a wide spectrum of properties is tabulated for each solvent.

The introductory chapters on the history, development, and use of coal and petroleum are particularly excellent. The more than 500 hydrocarbon solvents have many relationships in common and, as mentioned above, the distillation range was chosen as a pivotal means for bringing those solvents with similar properties into closer proximity. This provides a scientific means of selection and use.

The chemical compositions of many solvents are included. This is particularly important, since many compounds are mixtures and their solvency is difficult to predict. Evaporation rate is the third principal property which should be known for solvent selection. This is given, along with such other properties as specific gravity, flash point, Kauri butanol value, dilution ratio, doctor test, corrosion, sulfur, and viscosity.

"Polythene." Edited by A. Renfrew and Phillip Morgan. Iliffe & Sons, Ltd., London, England. Cloth, 6 by 9-¾ inches, 642 pages. Price $18.50 from Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y.

The chapters are grouped under three main headings: Manufacture and Properties, Processing Techniques, and Applications. Stated purpose of the work is a critical appraisal of all available data, plus a prediction of future trends. Contributions were received from experts throughout the United Kingdom and the United States.

One can best obtain an idea of the book's scope by an examination of the table of contents. Chapters under manufacture and properties include: "History of Polythene," "Raw Materials & Manufacturing Processes," "Reaction Kinetics of Ethylene Polymerization," "Compounding," "Pigmentation," "Oxidation & Aging," "Molecular Structure," "Dielectric Properties," "General Mechanical Properties," "Chemical Properties," "Testing & Specifications," "Low Molecular Weight Polythene," "Irradiated Polythene," and "Modified Polythene."

Processing covers "Extrusion Problems & Screw Design," "Extrusion of Polythene Cable Covering," "Extrusion of Tube, Rod, & Profile," "Extrusion of Tubular & Flat Polythene Film," "Injection Molding," "Centrifugal Casting of Large Diameter Pipe," "Paper Coating," "Bottle Production," "Sprayed Coating," and "Dip Coating."

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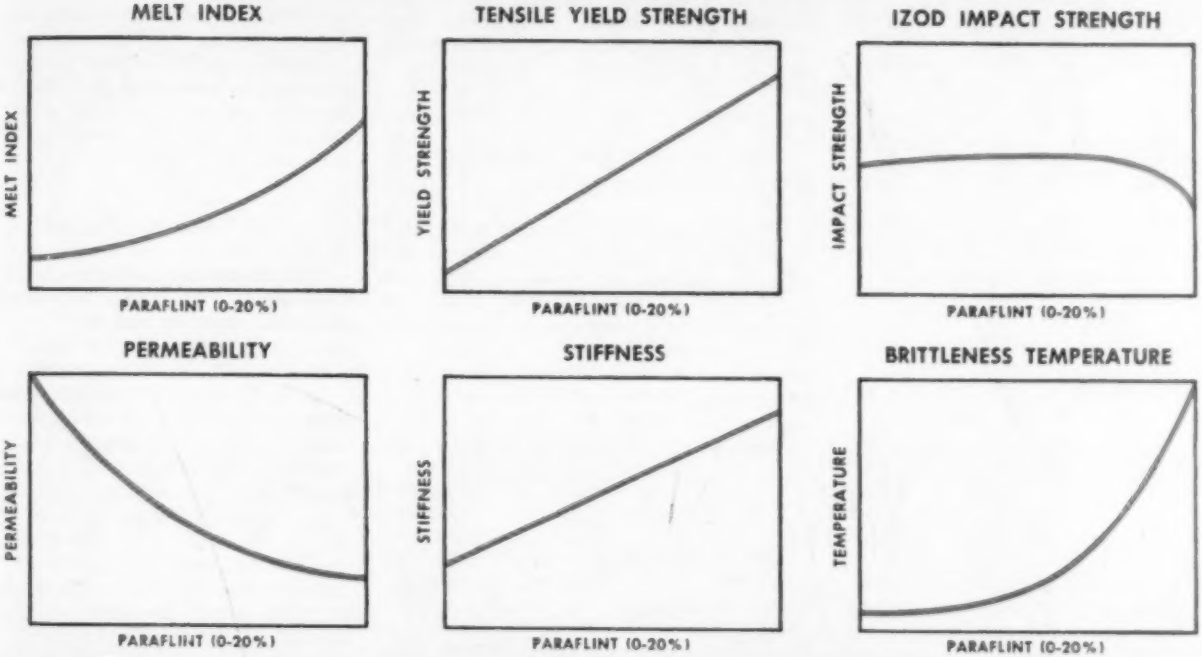

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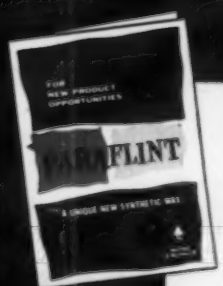

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Abstracts of Important Articles

Materials

"Castor Oil and its Derivatives," E. J. Mouton, *Plastics (London)*, 9, 12, 734 (Dec. 1956).

The importance of castor oil in industry has grown rapidly following the development of hydrated castor oil and derivatives. A number of products are discussed briefly, including esters as plasticizers, Rilsan, (the new polyamide), and the uses of sebacic acid. (In Dutch).

"Materials for Vacuum Forming," K. R. Greer, *Trans. Plastics Inst.*, 25, 59, 69 (Jan. 1957).

The materials considered are rigid PVC, vinyl copolymers, cellulose acetate, acrylics, polystyrene, and modified polystyrene.

"Polyesters and Ester Polymers of Polyfunctional Alcohol or Carboxylic Acids," G. Tewes, *Gummi u. Asbest.*, 9, 10, 567; 9, 11, 606; 9, 12, 684; 10, 1, 23; 19, 2, 68. (Oct., Nov., & Dec. 1956; Jan. and Feb. 1957).

This review, based mainly on American, British, French, and German patents, is intended to supplement the last comprehensive description of polyesters in the German language, published in 1943. A summary of the scientific and technical situation at that time is followed by a discussion of the production and treatment of condensation products from polybasic acids and polyhydric alcohols, hydrocarboxylic acids, and polymers from unsaturated esters, largely with the problems of the producer and converter in mind. A number of patents are listed. (In German).

"Forming High Polymers by Metal Reinforcement of Polymeric, Film-foaming Compositions Containing Oil, and of Different Synthetic Resins," F. Schlenker, *Kunststoffe*, 47, 1, 7 (Jan. 1957).

Investigations at the Chemische Werke Albert, Wiesbaden, revealed the possibility of producing high polymers from low molecular-weight compounds having potentially functional groups by metallic reinforcement (reaction with organic metal compounds whose polyvalent metal atoms are capable of reacting with a potentially functional group). The stabilized aluminum alcoholates proved to be especially useful for the purpose. The method of preparing them and results obtained are reviewed chiefly with reference to materials for varnishes and lacquers, including alkyd resin/oil products, modified phenol resins, and epoxy resins. The possibilities of reacting active metallic compounds with polysiloxane resins, and of forming new metal-containing plastics from simple monomers of organic metal compounds are to be discussed at a later date. Results so far point to a new way of bridging the gap between purely organic plastics and those largely of inorganic nature. (In German).

"Polyethylene Chlorosulfonate," A. Bosoni, *Mat. Plastiche*, 22, 10, 790 (Oct. 1956).

Polyethylene chlorosulfonate is prepared by treating polyethylene with chlorine and sulfurous anhydride; it is an elastomer with physical and chemical properties (tensile strength; abrasion resistance, and ozone resistance) superior to those of natural and synthetic rubbers. The method of preparation, vulcanization, mechanical and general properties, and applications are discussed. (In Italian).

"Testing the Degree of Gelling in PVC Leathercloth," F. Schimke, *Kunststoffe*, 46, 11, 537 (Nov. 1956).

The method developed by Kling for determining whether plasticized PVC was properly gelled consisted of subjecting a sample folded over the edge of a metal strip to the action of ethyl acetate. Incompletely gelled samples showed breaks in the surface ranging from slight crazing to flaking off, depending on the degree of under-gelling. Completely-gelled materials did not show these effects during the test. The method, very slightly modified, was tested for its practical value, and found to be quick and reliable, especially for dipped and cast products, and extruded and calendered goods. (In German).

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Requests for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in September.

"Dielectric Properties of Plastics and Other Non-Conductors," B. H. Daimler, *Kunststoffe*, 46, 11, 508 (Nov. 1956).

The behavior of plastics as poor conductors of electricity is of considerable interest to the scientist and electrical engineer alike. In the present article, the author attempts to present as clearly as possible the relationships between the processes which take place in the molecules of materials (solid and liquid) and the dielectric measurements which have been developed to permit their use in electrical engineering and which are also used in studying the structure of materials. The values for dielectric constant, conductivity or loss factor, and dielectric strength, for both AC and DC currents, under normal engineering conditions are related to the internal processes of the material, and various data are summarized in tabular form. (In German).

"Measuring the Evolution of Hydrogen Chloride in PVC Cable Compounds over Extended Periods and at Various Temperatures," B. Schmitt and F. Heck, *Kunststoffe*, 46, 12, 555 (Dec. 1956).

In this method of determining the heat stability of PVC cable compounds, which is similar to that of Arlman, the hydrogen chloride liberated at any temperature is registered as a function of time. The gaseous decomposition products split off during the heating of the PVC samples are passed through conductivity water, and the resulting change in conductivity is recorded. From the curves obtained, the amount of hydrogen chloride can be calculated and, in turn, the rate of decomposition. (In German).

"A Spray Method of Applying Polyurethanes," H. C. Fornwall, *SPE J.*, 13, 1, 19 (Jan. 1957).

Discussion of the DeVilbiss spray equipment for catalyst finishes.

"Brazing Fundamentals," P. D. Pilibosian, *SPE J.*, 13, 1, 25 (Jan. 1957).

Basic discussion of the brazing method and its results.

"Polyester Laminating Resins," J. Brydson and C. W. Welch, *Plastics, (London)*, 21, 229, 282; 21, 230, 322 (Oct. & Nov. 1956).

In examining some of the lesser-known aspects of polyester resin chemistry, the cross-linking reaction and catalysts, and, in particular, the mechanism of cold cur-

ing with a peroxide catalyst and a metallic accelerator were examined. The effects of varying catalyst and accelerator, temperature, different metallic naphthenates, and varying styrene contents also were studied. A theoretical mechanism for the cross-linking reaction is proposed which is thought to fit the known facts, and also be in accord with current theories on addition polymerization and modern drying oil chemistry.

"Performance Factors in Injection Molded Polyethylene Domestic Ware," A. B. Glanvill, *Plastics, (London)*, 21, 229, 264 (Oct. 1956).

The performance of domestic ware injection-molded from low-density polyethylene is considered from various aspects such as service conditions, material characteristics in relation to functional usage, and the influence of manufacturing conditions.

"From Silicon to Silicones," P. Piganiol, *Ind. Plastiques Mod.*, 8, 8, 41; 8, 9, 37 (Sept.-Oct. & Nov. 1956).

In a series of seven short papers, the author explains the structure and reactions of the silicon atom, the nature of various natural silicates, and how this knowledge and that gained in the production of organic plastics have served to develop the silicones. The uses of silicone fluids and rubbers, and the industrial and commercial aspects also are discussed. (In French).

"Epoxy Resins," A. Sandri, *Poliplasti*, 4, 16, 4 (July-Aug. 1956).

The preparation of epoxy resins is described briefly, also their principal applications in varnishes, adhesives, casting and potting resins, and laminates. In a separate table, 81 items using epoxy resins are listed, together with the names of the Italian suppliers, the way in which the resin is employed, and the reasons for its use. (In Italian).

"Isotactic Polymers," E. Fachinelli, *Poliplasti*, 4, 16, 21 (July-Aug. 1956).

Based on articles published by G. Natta and collaborators, the author describes the structure, method of preparation, and physical and chemical properties of the new isotactic polymers produced by the Natta process from alpha-olefine aliphatics and styrene with the aid of "stereospecific" catalysis. (In Italian).

"Recent Developments in Epoxy Resins," J. H. van der Neut, *Plastica*, 9, 10, 615 (Oct. 1956).

At present, the curing agents used most commonly for the classic epoxy resins include acid anhydride, and modified and unmodified amines and polyamides. The advantages and disadvantages of these agents are reviewed, and present and potential applications of epoxy resins discussed briefly. (In Dutch).

"Ionizing Radiations and Macromolecules," A. Chapiro, *Ind. Plastiques Mod.*, 8, 9, 67; 9, 1, 41; 9, 2, 34. (Nov. 1956; Jan., Feb. 1957).

This is a detailed review of what has been achieved so far in the investigation and use of ionizing radiations in macromolecular chemistry. Of the three parts into which the article is divided, the first is devoted to radiochemical polymerization of different vinyl monomers: (1) in a homogeneous medium (styrene, methylmethacrylate, and copolymers); (2) in a precipitating medium (acrylonitrile, vinyl chloride, ethylene); (3) in an aqueous solution (acrylic amide, vinyl pyrrolidine, methacrylic acid); and (4) in the solid state (methylacrylate). In Part II, mention of the physical and physico-chemical methods of detecting the effects of irradiation on solid polymers, and the four principal changes resulting therefrom, precedes a systematic study of cross-linking (in polyethylene, rubber, polystyrene, polysiloxane, and PVC) and degradation (Plexiglas, polyisobutylene, Teflon, and cellulosics) brought about by radiations. Tables of the yields of such cross-linking and degradation are given. In Part III, irradiation of polymer solutions is dealt with, including cross-linking and degradation effects, and the use of supersonics. Finally, the synthesis of copolymer grafts by two methods is considered: irradiation of a Polymer A in contact with a Monomer B; and pre-irradiation of a Polymer A in the presence of oxygen, followed by contact of the latter with Monomer B. The advantages of the two methods are compared, and possibilities of the resulting products are mentioned. Each of the three parts has its bibliography, with a total of 267 references. (In French).

Applications

"Vinyl Acetate Resins for the Packaging Industry," G. Balestrieri, *Materie Plastiche*, 22, 8, 625 (Aug. 1956).

The uses of polyvinyl acetate, polyvinyl alcohol, and vinyl copolymers are considered in adhesives for cardboard containers, in treating paper and cardboard to improve its properties and appearance, in coating the interiors of metal and wood drums for solvents (chiefly hydrocarbon solvents), and in sealing metal drums. A few formulas for suitable adhesives are given. (In Italian).

In this plant making plastic printing plates, each press *has its own Speedylectric steam boiler.* Each press is independent of the others, and each gets steam at the right temperature and pressure. There is no big boiler to waste power when only one or two presses are needed, and it takes only minutes to bring a press up to temperature for a rush order.

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Patent Digest

Materials

Condensation and Polymerization Products of Aldehydes with Ketone Cyanohydrins and a Method of Making Same. No. 2,778,811. Arthur Ullrich, Neckargemuend, Germany.

A cyanohydrin of a ketone is heated with an aliphatic aldehyde in the presence of a basic agent to a temperature between 60-80° C., for a period of time sufficient to inter-resinify the cyanohydrin and the aldehyde.

Purification of Plasticizer Esters. No. 2,778,849. Oscar Ackelsberg, Bloomfield, N. J. (to William M. Hackman, Watchung, N. J.).

Di-alkyl esters of organic dicarboxylic acids are 99-100% purified and deoderized. These esters are liquid and stable at a temperature beween 100 and 160°. They are maintained within these temperature limits and subjected to an absolute pressure not greater than 100 mm. Hg. Live steam is injected into the ester until the desired purity is reached.

Olefin Polymerization Catalyst and Process. No. 2,778,804. Eugene S. Corner, Maplewood, and Charles S. Lynch, Plainfield, N. J. (to Esso Research and Engineering Co.).

An olefin polymerization catalyst is produced by forming an intimate mixture of a silica hydrogel containing from 50-90% by weight of water, and a phosphoric acid. The mixture is dried, and the catalyst is calcined at an elevated temperature.

Flame Retardant Polyester Resinous Compositions Containing Halogen. No. 2,779,700. Paul Robitschek, Buffalo, and Claude Thomas Bean, Jr., Niagara Falls, N. Y. (to Hooker Electrochemical Co., Niagara Falls, N. Y.).

A polymerizable, linear polyester containing an adduct of hexahalocyclopentadiene and a polyhydric alcohol containing aliphatic carbon to carbon unsaturation are mixed with a polycarboxylic acid and a polymerizable compound, both containing aliphatic carbon to carbon unsaturation.

Vapor Drying of Cellulose. No. 2,773,865. Earl Ralph Purchase, Waynesboro, Va. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

A process for the removal of moisture from raw cellulose involves contacting the cellulose with a stream of hot air which has been dried to a low humidity by passage through a column of concentrated sulfuric acid and then mixed with vapors of acetic acid.

Pretreatment and Esterification of Cellulose. No. 2,773,866. Lejaren Arthur Hiller, Jr., and Fenton Hendy Swezey, Waynesboro, Va. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

A cellulose ester which is saponifiable to an acetone-soluble form is made by commingling cellulose with an aqueous solution of strong mineral acid to effect depolymerization. The degraded cellulose is washed free of acid and esterified in the presence of a non-depolymerizing catalyst consisting of sodium and potassium salts, and an activating medium.

Dyeing of Polyesters With Vat Dyes. No. 2,774,647. Jerry M. Mecco, Somerville, and Joseph W. Creely, East Bound Brook, N. J. (to American Cyanamid Co., New York, N. Y.).

Fibrous polyesters of a glycol and a polycarboxylic acid are dyed by heating the fibers in an aqueous dye-bath containing an unesterified leuco vat dye, a reducing agent, and sodium tripolyphosphate which acts as a buffer to maintain the pH value of the bath between 6.5 and 7.5. After the dyeing is complete the dyestuff is oxidized on the fiber.

Treatment of Synthetic Polymeric Materials to Impart Dye Affinity Thereto. No. 2,773,856. Robert Meyer, Tassin-la-Demi-Lune, and Pierre Alphonse Garnier, Lyon, France. (to Societe des Usines Chimiques, Rhone-Poulenc, France).

Dye affinity is imparted to an acrylonitrile polymer by heating the polymer in solution with a hydrocarbon sulphonic acid and a hydrocarbon amine. The combined quantities of the sulphonic acid and the amine must be not less than 23% and not more than 75%, by weight, of the polymer. The solvent is removed to form a solid composition of acrylonitrile, amine, and sulphonic acid.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Method of Preparing Expanded Urea. No. 2,773,858. Manuel H. Gorin and Ludwig Rosenstein, San Francisco, Cal.

An adduct, prepared by reacting urea with an organic compound consisting of linear hydrocarbons and fatty acids, is suspended in a solvent. The adduct is decomposed by heating to a temperature between 40-115° C., for a period of 5-90 minutes. The resulting expanded urea is separated to form a light and fluffy powder having a bulk density less than 0.5 gram per cubic centimeter.

Lamination of Chlorinated Olefins. No. 2,774,705. Richard A. Smith, Cornwall on the Hudson, N. Y. (to M. W. Kellogg Co. Jersey City, N. J.).

A chlorinated olefin surface is bonded to another surface under the application of heat and pressure, following coating one of the surface with a liquefiable polymer of trifluorochloroethylene having a softening point below 150° C. The surfaces are brought into contact under a pressure of at least 5 psi., and at a temperature above 135° C. and below the decomposition temperature of the surfaces and the liquefiable polymer.

Manufacture of Fluorine Containing Polymers. No. 2,774,751. Herbert J Passino, Englewood, and Albert L. Dittman. North Bergen, N. J. (to M. W. Kellogg Co., Jersey City, N. J.).

A normally solid fluorine-containing polymer is produced by polymerizing a substituted ethylene compound at a temperature of 0-40° C., in the presence of an aqueous suspension medium having an inorganic peroxide as a polymerization promoter, a reducing agent as an activator, and an iodide as an accelerator.

Pigmented Organic Plastics and Method for Preparing Same. No. 2,773,044. Vincent C. Vesce, Smoke Rise, Kinnelon, N. J. (to B. F. Goodrich Co., New York, N. Y.).

An alkyd resin plastic and a pigment are milled in a liquid grinding medium composed of water and a liquid solvent. The grinding medium should be sufficient to give fluidity to the mixture and permit effective milling action, while neither dissolving substantial amounts of the plastic nor causing excessive agglomeration. The milling is continued until the pigment is completely dispersed, after which the solid and liquid portions of the mixture are separated.

Equipment

Extrusion Nozzle. No. 2,778,322. Frank T. Moser, Easton, Pa.

The nozzle comprises a frustro-conical sleeve member having open ends. The larger, open end is provided with outwardly-inclined teeth extending along its entire peripheral portion, and a plate member of substantially the same size and contour. An orifice is provided with

radially-directed teeth about its periphery. Plate and sleeve members are joined by relatively wide teeth spaced circumferentially around their respective peripheries so as to confront each other, and joined by a weld. The connecting teeth are wider at their ends than the remaining teeth, so that arcuate-spaced openings are formed between the members.

Processing

Forming Foamed Polyurethane Resins. No. 2,779,689. Joseph J. Reis, Jr., Pittsburgh, Pa. (to Pittsburgh Plate Glass Co., Pittsburgh, Pa.).

A liquid, anhydrous, relatively-stable prepolymer of a diisocyanate, a polyester of an alcohol containing at least two hydroxyls and a dicarboxylic acid, and an aqueous dispersion of a polyester which is also an alcohol containing at least two hydroxyls and a dicarboxylic acid are sprayed through two separate nozzles onto a solid surface. Foaming and curing of the mixture results.

Apparatus and Method of Forming Elongate Articles from Fiberglas. No. 2,779,388. Henry N. Quoss, Dallas, Tex.

The apparatus comprises a supported roll of fibrous material; a dip tank containing a quantity of thermosetting resin maintained at a given temperature; a second tank, also containing resin, connected to the first, and provided with a means for maintaining temperature; means for coating the web by submerging it in the dip tank; a pair of squeeze rollers between which the web is passed to evenly distribute the resin and remove the excess; a series of spaced sets of dies through which the web is drawn in a plastic state to shape it; a straightening die through which the web is drawn in its final hardening stage; a plurality of heads for spraying the web after hardening; means for curing fit by the uniform application of heat; and a system for recirculating the resin through both tanks and the spray heads.

Method of Manufacturing Hard Surface Covering with Partial Removal of the Selvage Bands. No. 2,779,487. Edward G. Schairer, Manheim Township, Lancaster County, Pa. (to Armstrong Cork Co., Lancaster, Pa.)

A continuous web of backing material is fed into the nip of a calender in engagement with one of the rolls. A plastic composition is calendered onto and beyond the edges of the backing, thus forming a continuous sheet. The plastic sheet is severed lengthwise and removed from the roll. The side portions of the sheet are permitted to encircle the roll forming selvage bands which are removed partially to expose a portion of the roll between selvage bands.

Destaticization of Plastic Articles. No. 2,778,748. Richard G. Rowe, Redding Ridge, and Guiles Flower, Jr., Darien, Conn. (to Dictaphone Corp., Bridgeport, Conn.).

An anti-static plastic article consisting of a sound-recording medium molded from synthetic resins and cellulosic plastics is coated with a thin layer of heptadecyl imidazoline ethanol.

Determination of Solids in Liquids. No. 2,779,189. Ernest R. Corneil, Stamford Centre, Ontario, Canada. (to E. I. du Pont de Nemours, Wilmington, Del.).

A method for determing the solids content of a PVA emulsion whcih comprises immersing therein, a metal mass having a volume not greater than 0.1% of the emulsion voluume and heated to at least 500° F. The time required for the immersed metal mass to cool to a temperature not greater than 211° F. is recorded.

Applications

Awnings. No. 2,778,071. George W. Anderson, Port Washington, N. Y.

A resilient sheet of plastic material, capable of restoring itself to a flat condition after being curved, is used in an awning supported from a wall structure. A bead is attached to the sheet at its inboard edge, while a channel member encloses its outboard edge. A moulding, having a longitudinal channel for retaining the bead and a slot for the passage of the sheet, carries a means for engaging the bead and locking it within the channel. The sheet is restrained in a state of curvature corresponding to the convex surfaces of frames that engage its edges. The sheet is locked between the flange and the surfaces of the frame by removable studs.

Moisture Proof Heat Sealable Wrapping Material. No 2,778,760. Reginald H. Hurst, Parchment, Mich. (to Kalamazoo Vegetable Parchment Co., Parchment, Mich.).

The laminated sheet comprises an outer ply of printable white paper and an inner ply of aluminum foil, bonded throughout with microcrystalline wax. The laminated sheet is coated on both sides with microcrystalline wax, paraffine wax, and a polyethylene resin having a molecular weight between 10,000 and 22,000. The proportion of polyethylene to wax is 2-10:98-90.

Filters for Tobacco Comprising Cellulose Esters and Ethers. No. 2,780,228. George P. Touey, Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N. Y.).

The filter comprises a structurally unitary, elongated, rod-like mass of crimped fibers of an ester of cellulose and a polybasic acid. The fibers of the mass are parallel with the longitudinal axis, and the ester has at least one free, reactive acid group for each 10 anhydroglucose units of the cellulose.

Package with Cellular Plastic Packaging Means. No. 2,780,350. Eli Simon, Los Angeles, and Frank W. Thomas, Burbank, Cal. (to Lockheed Aircraft Corp., Burbank, Cal.).

The package consists of a first container in which a yielding mass of resilient, cellular, plastic supports the object in spaced relation with the walls. A second container, holding a mass of rigid cellular plastic, receives the first container.

Flexible Index Strips in Sheet Form. No. 2,778,658. Hall Young Kaighin, New York, N. Y. (to Acme Visible Records, Inc., Crozet, Va.).

One surface of a white, nonfibrous plastic material, is provided with a matte finish adapted to receive typed ink impressions. The sheet is formed of longitudinally-spaced transverse slits of limited depth, which define a plurality of hingedly-connected, elongated strips. The latter are separable from each other, and respond to pivotal movement so that adjacent strips may be placed in back-to-back engagement. The sheet is sufficiently resilient to return from a bowed to a flat condition.

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Patent Digest (Con't. from page 677)

Tapered Leader for Fishing Purposes from Synthetic Polymers. No. 2,774,173. Heinz Thiennemann, Beuel, Germany.

A tapered leader having excellent throw characteristics is formed from a 1.8-3.5 meter length of synthetic linear high polymers. The diameter decreases at different rates from a maximum point on the leader to the two ends. The distance from the maximum diameter to the finer of the two ends is at least twice the distance from the maximum diameter to the coarser end.

Noise Attenuating Ear Protectors. No. 2,782.423. Eli Simon, Los Angeles, Frank W. Thomas and Phillip J. Wiegand, Burbank, Cal. (to Lockheed Aircraft Corp., Burbank, Cal.).

Consisting essentially of polyurethane, the protector comprises a main web extending across the external ear. This web has a concave inner surface and thickened marginal bead, the latter having a rounded inner edge to present line contact with the user's head. The bead follows the concave configuration of the web which is offset rearwardly with respect to the rounded inner edge. The rear portion of the web encases a thin, dished, bendable reinforcing plate in such a manner as to leave the major inner portions of the pad free to conform to cranial contours.

Deformable Plastic Nut Having Wire Coil Insert Threads Retained Therein. No. 2,775,281. Byrom J. Smith, Danbury, Conn. (to Heli-Coil Corp., Danbury, Conn.).

A cylindrical wire coil is embedded within a plastic barrel having high tensile strength and shear resistance. The coil forms a female screw-thread, and is so positioned that the barrel extends beyond one or both of its ends. The barrel extension contains an interior thread having the same pitch and shape of the female thread, and acts as a continuation thereof. The extension's bottom face bears on the surface of a screw connection in such a manner that it will be compressed between the surface and the coil when the nut is tightened.

Current Market Prices

Price Changes and Additions

Resins and Molding Compounds

Polyesters

Vibrin 114, 117, 152, 154	$0.35 /	$0.365
115A	.39 /	.405
121	.47 /	.485
142	.51 /	.525
151, 156	.36 /	.375
152 LS-4	.365 /	.38
A-601	.50 /	.515
B-801	.595 /	.61
X-1098	.34 /	.355

Polyethylene

Petrothene 100, 101, 200, 201, 202, 203, 205, 206, 207, 208, 301	.35 /	.45
300, 300-200	.465 /	.565
300-6	.425 /	.525
301, electrical grade	.41 /	.51
301-6	.37 /	.47
301-200, 301-202, 302-506, 560	.375 /	.48
302-6	.39 /	.49

Vinyls

Escambia 1200, 1225, 1250	.27 /	.47
Exon 402A, 500, 905, 915, 925	.27 /	.47
450, 468, 480	.32 /	.52
461	9.75	
470	.48 /	.68
471	.45 /	.65
481	.39 /	.59
485	.37 /	.57
654	.30 /	.50

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CALENDAR of COMING EVENTS

Sept. 17-18
Fourth meeting, Plastics Study Group, Building Research Inst. Washington U., St. Louis, Mo.

Sept. 18
SPE New York Section. Governor Clinton Hotel, New York, N. Y.

Sept. 25
Reinforced Plastics Group. SPE New York Section. Tufaro's Restaurant, Corona, L. I., N. Y.

Oct. 3
SPE Western New England Section. Terrace Rm., Bradley Field, Windsor Locks, Conn.

Oct. 4
SPE Southern California Section. Scully's Restaurant, Los Angeles, Calif.

Oct. 7-9
Paper-Plastics Conference. Technical Assoc. of the Pulp & Paper Industry. Sheraton-Gibson Hotel. Cincinnati, O.

Oct. 8
SPE Milwaukee Section. Bavarian Club, Milwaukee, Wisc.

Oct. 10-11
SPI annual New England Section Conference. Wentworth Hotel. Portsmouth, N. H.

Oct. 11
SPE Connecticut Section. Hotel Barnum, Bridgeport, Conn.

Oct. 14
SPE Cleveland-Akron Section. Spanish Tavern, Brecksville, O.

Oct. 16
SPE New York Section. Governor Clinton Hotel, New York, N. Y.

Oct. 17
SPE Pittsburgh Section. Cappy's Restaurant, Pittsburgh, Pa.

Oct. 21
SPE Upper Midwest Section. Warwa's Cafe. Minneapolis, Minn.

Oct. 22
SPE Philadelphia Section. Franklin Inst., Philadelphia, Pa.

Oct. 23
SPE Quebec Section. Queen's Hotel, Montreal, P. Q., Canada

Oct. 30
Reinforced Plastics Group. SPE New York Section. Tufaro's Restaurant, Corona, L. I., N. Y.

Domestic Production and Sales of Plastics and Resin Material, March and April, 1957

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of March and April, 1957. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Checking against the same months in 1955 and 1956, we find cellulosics, ureas, and melamines remaining about the same. All other materials show gains but phenolics, which show a loss of about 10%. Really large gains are evidenced by vinyls and polyethylenes. Polyesters, while small in total volume (8½-million pounds), show sales increase of about 40%.

	March, 1957		April, 1957	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.03 gage	1,899,375	1,770,363	1,703,261	1,436,827
Sheets 0.003 gage and over	1,704,779	1,599,891	1,554,943	1,459,871
All other sheets, rods, and tubes	648,481	688,404	564,787	613,983
Molding and extrusion materials	8,289,358	8,212,800	7,167,567	7,114,722
Nitrocellulose sheets, rods, and tubes	378,827	359,233	357,097	329,555
Other cellulose plastics	500,369	448,476	527,617	459,880
TOTAL	13,421,189	13,079,167	11,875,272	11,414,838
Phenolic and Other Tar-Acid Resions:				
Molding materials[1]	17,860,884	14,225,481	12,880,812	14,234,104
Bonding and ad esive resins for—				
Laminating (except plywood)	5,594,690	3,746,589	5,012,669	3,951,163
Coated and bonded abrasives	1,513,483	1,472,404	1,341,558	1,261,739
Friction materials (brake linings, clutch facings, and similar materials)[7]				
Thermal insulation (fiber glass, rock wool)	3,970,446	4,139,330	4,195,330	3,857,968
Plywood	3,576,367	2,561,139	4,052,442	3,157,095
All other bonding and adhesive uses	4,166,653	3,840,624	4,146,458	4,181,758
Protective-coating resins, unmodified and modified excpet by rosin	2,625,173	2,420,249	2,401,613	2,083,705
Resins for all other uses	3,133,694	2,652,701	2,896,462	2,884,222
TOTAL	42,441,390	35,058,517	36,927,374	35,611,754
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	3,202,514	3,238,491	3,344,321	2,830,681
Paper-treating and Paper-coating resins	2,490,868	2,014,752	1,916,445	1,630,626
Bonding and adhesive resins for—				
Plywood	8,829,335	7,995,949	7,921,894	7,609,044
All other bonding and adhesive uses, including laminating	2,798,595	2,146,358	2,035,413	2,392,267
Protective-coating resins, straight and modified	3,307,771	2,837,058	3,190,940	2,150,635
Resins for all other uses, including molding	8,588,234	7,883,552	7,477,107	8,125,610
TOTAL	29,217,317	26,116,160	25,886,120	24,738,865
Styrene Resins:				
Molding materials[1]	37,448,043	37,448,043	36,652,709	35,651,931
Protective-coating resins, straight and modified	7,251,558	6,351,073	7,370,805	6,904,368
Resins for all other uses	13,671,964	11,696,117	12,054,882	10,522,721
TOTAL	58,292,788	55,495,233	56,078,396	53,079,020
Vinyl and Vinyl C loride Resins:[3]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		8,589,219		7,036,420
Sheeting (resin content)		5,272,272		4,190,687
olding and extrusion (resin content)		20,122,773		18,180,448
Textile and paper treating and coating (resin content)[5]		5,439,636		4,627,569
Flooring (resin content)		6,879,365		7,889,657
Protective coating (resin content)		2,798,246		3,495,028
All other uses (resin content)		4,172,739		4,200,988
All other vinyl resins for—				
Adhesives (resin content)		3,371,907		3,846,603
All other uses (resin content)		10,060,268		8,797,484
TOTAL	70,418,716	66,706,425	68,679,026	62,264,884
Coumarone-Indene and Petroleum Polymer Resins	24,382,250	23,702,546	22,174,005	22,406,062
Polyester Resins	8,617,609	7,762,446	8,961,157	7,594,629
Polyethylene Resins	56,587,377	51,167,832	51,792,818	54,555,030
Miscellaneous Synthetic Plastics and Rein Materials:				
Molding materials[1, 4]	4,193,551	4,022,677	3,825,285	3,905,263
Protective-coating resins[6]	1,183,796	539,505	1,067,090	552,896
Resins for all other uses[5]	11,234,643	10,572,778	11,809,890	10,608,907
TOTAL	16,611,990	15,134,960	16,702,265	15,067,066
GRAND TOTALS	319,796,515	294,223,286	299,076,433	286,732,147

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, nylon, silicone, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
[7]Included with „All other bonding and adhesive uses."
SOURCE: United States Tariff Commission, Chemical Division.

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